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Development of Methods and Analysis of Particulate Sampler Data from RAPS (Regional Air Pollution Study)

System Sciences, Inc.
Chapel Hill, NC

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Methods were formulated, tested and demonstrated to statistically analyze and graphically process analytical data derived from dichotomous particulate samplers operating at ten Regional Air Monitoring System (RAMS) stations in the greater St. Louis area. Statistical techniques and computer programs are documented in this report. Time series plots of 24 hr averages of total mass and sulfate for high volume and dichotomous sampler instruments are presented. Quarterly means and standard deviations of total mass and sulfate are tabulated for each station for high volume and dichotomous samplers. Correlations between high volume and dichotomous sampler measurements of total mass and sulfate are computed for each station. Frequency distributions are plotted for the fine/total ratio of total mass, sulfate, and lead at each station for dichotomou sampler measurements. Correlations between the fine and coarse fractions for 23 elements plus total mass at each station for dichotomous sampler measurements are presented.

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DEVELOPMENT OF METHODS AND ANALYSIS OF PARTICULATE SAMPLER DATA FROM RAPS

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ABSTRACT

Methods were formulated, tested and demonstrated to statistically analyze and graphically process analytical data derived from dichotomous particulate samplers operating at ten Regional Air Monitoring System (RAMS) stations in the greater St. Louis area.

Statistical techniques and computer programs are documented in this report and the sample outputs are presented for the following tasks:

- Time series plots of total mass and sulfate 24 hr averages for high volume and dichotomous sampler instruments
- Means and standard deviations of total mass and sulfate by station by quarter for high volume and dichotomous samplers
- Correlations between high volume and dichotomous sampler measurements of total mass and sulfate at each station
- Scatterplots of high volume vs. dichotomous sampler measurements for total mass and sulfate at each station
- Frequency distributions for the fine/total ratio of total mass, sulfate, and lead at each station for dichotomous sampler measurements
- Correlations between the fine and coarse fractions for 23 elements plus total mass at each station for dichotomous sampler measurements
- Correlations among six selected elements and total mass at each station by fraction for dichotomous sampler measurements

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SECTION 1

INTRODUCTION

A recently developed technique, using the dichotomous sampler coupled with X-ray fluorescence analysis of samples, has facilitated the collection of data relating to the mass and elemental distributions in particulate matter collected from ambient air in two different size ranges. The data consist of measurements taken in the years 1975, 1976, and 1977 at ten sites in the greater St. Louis area. Sampling periods ranged from 2 to 12 hours with data being collected continuously. The sites coincided with 10 of the 25 sites of the Regional Air Monitoring System (RAMS), a part of the Regional Air Pollution Study (RAPS). Site locations ranged from urban to rural areas at varying distances from a variety of industrial point sources as well as sources of emissions from mobile vehicles. Data generated by the RAMS monitoring program itself include particulate mass and sulfate from a standard hi-volume sampler as well as a variety of measurements of other atmospheric conditions.

The wealth of data produced provides a unique opportunity for investigating relationships between air quality and emissions as well as the spatial and temporal characteristics of ambient pollutant concentrations. The work reported herein consists of the development and implementation of computer-assisted methodology for presentation and analysis of dichotomous particulate sampler data. In particular, the tasks completed involve:

- Time series plots of total mass and sulfate 24 hr averages for high volume and dichotomous sampler instruments
- Means and standard deviations of total mass and sulfate by station by quarter for high volume and dichotomous samplers
- Correlations between high volume and dichotomous sampler measurements of total mass and sulfate at each station

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- Scatterplots of high volume vs. dichotomous sampler measurements for total mass and sulfate at each station

- Frequency distributions for the fine/total ratio of total mass, sulfate, and lead at each station for dichotomous sampler measurements

- Correlations between the fine and coarse fractions for 23 elements plus total mass at each station for dichotomous sampler measurements

- Correlations among six selected elements and total mass at each station by fraction for dichotomous sampler measurements

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SECTION 2

MONITORING

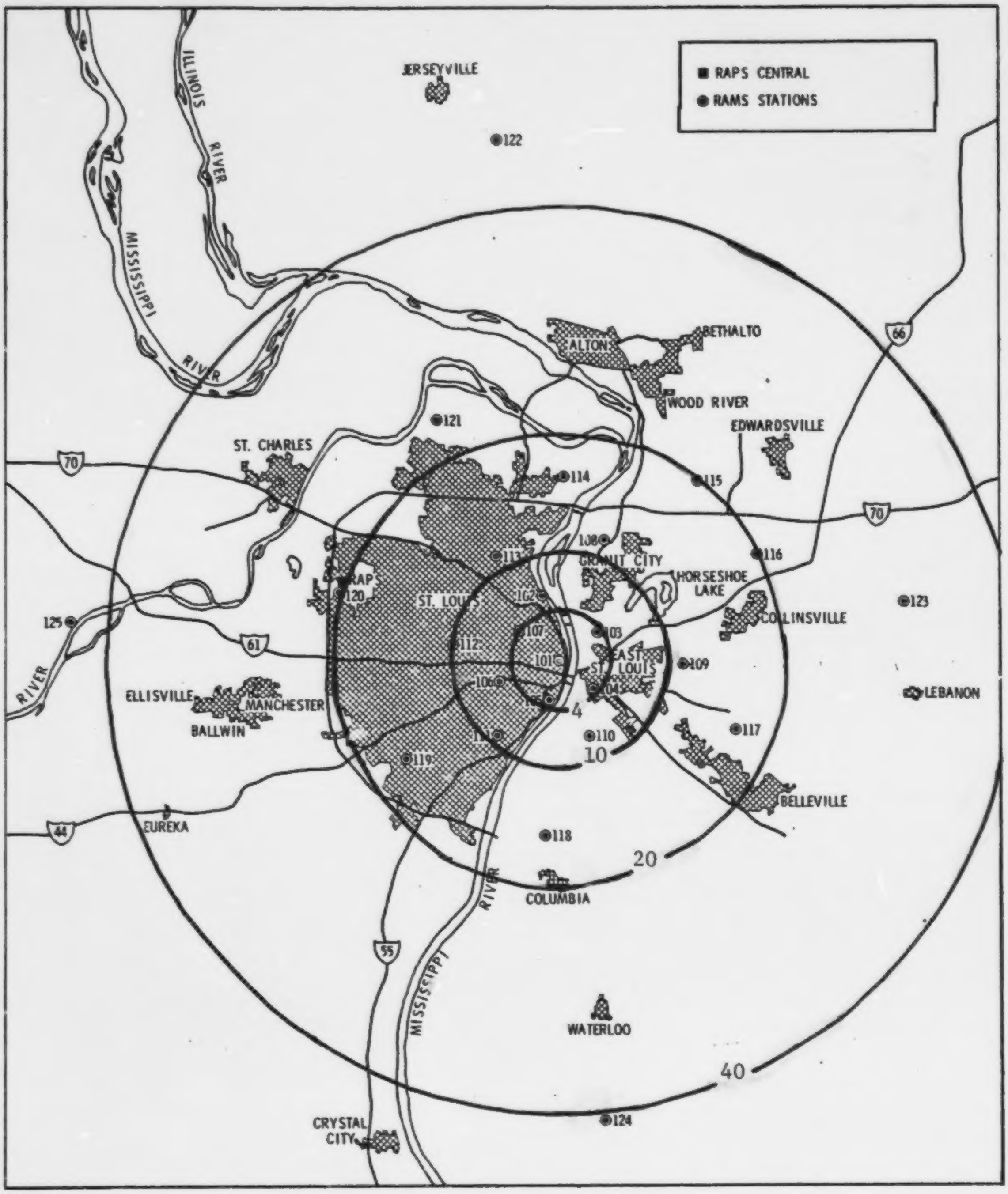
SITE DESCRIPTIONS

The RAMS network consisted of 25 stations strategically located throughout the greater St. Louis area. These sites lay along four concentric circles centered in downtown St. Louis with radii of 4, 10, 20 and 40 kilometers respectively (See Figure 1). The 25 sites represented a diverse range of sampling environments from heavily trafficked, inner city areas to industrial locations to agricultural settings. Specific location of sites was based primarily upon the extent of surrounding pollutant emission sources (stationary or mobile) and the significance of topographical features capable of influencing local air flow.

RAMS stations supported a variety of ambient air instruments which monitored particulate and gaseous pollutant levels as well as meteorological conditions (See Table 1). In addition, each site housed a computerized data acquisition system which effected daily transmittal of ambient air data to a central processor facility. RAMS station instrumentation collected data continually for a roughly two year period from March 1975 through March 1977. On-site validation and calibration routines were conducted as basic quality control measures.

A total of 10 sites out of the available 25 in the RAMS network maintained dichotomous and hi-volume samplers which collected particulate and trace element data (See Table 1). These ten sites are described in greater detail in the following paragraphs.

Site 103 is located in a rural area near National City, Illinois, several miles east of downtown St. Louis and the Mississippi River. The immediately surrounding area is largely characterized by agricultural


■ RAPS CENTRAL
● RAMS STATIONS
JERSEYVILLE
ILLINOIS RIVER
MISSISSIPPI RIVER
122
ALTON
BETHALTO
66
WOOD RIVER
EDWARDSVILLE
121
ST. CHARLES
70
114
115
70
108
GRANITE CITY
116
HORSESHOE LAKE
113
RAPS
120
ST. LOUIS
102
125
123
COLLINSVILLE
61
103
107
112
101
EAST ST. LOUIS
109
106
104
4
LEBANON
RIVER
ELLISVILLE
MANCHESTER
BALLWIN
110
117
10
119
BELLEVILLE
44
EUREKA
118
20
COLUMBIA
55
MISSISSIPPI RIVER
WATERLOO
40
124
CRYSTAL CITY

Note: Sites are aligned in approximate concentric circles of 4, 10, 20 and 40 KM respectively.

Figure 1. RAMS station locations.

Table 1. RAMS REMOTE STATIONS INSTRUMENT DISTRIBUTION

		101	102	103 ■	104	105 ■	106 ■	107	108 ■	109	110	111	112 ■	113	114	115 ■	116	117	118 ■	119	120 ■	121	122 ■	123	124 ■	125
O_3 - Monitor Labs 8410		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NO - NO_X Monitor Labs 8440		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CO - CH_4 - THC Beckman 6800		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TS - SO_2 - H_2S Tracor 270HA		X		X	X	X	X		X					X	X	X	X				X	X	X			
TS - Meloy SA 185			X					X		X	X	X	X					X	X	X				X	X	X
Visibility - MRI 1561		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wind Speed - MRI 1022 S		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wind Direction - MRI 1022 D		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Temperature - MRI 840-1		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dew Point - Cambridge 880		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Temp. Gradient - MRI 840-2		X	X		X	X	X	X		X		X	X	X									X	X		
Barometer - Sostman 363		X								X			X										X	X	X	X
Solar Radiation (Eppley)	Pyranometer			X	X				X						X				X				X			
	Pyrheliometer			X											X				X				X			
	Pyrgeometer			X											X				X				X			
Turbulence - R. M. Young 27002						X		X		X		X		X												
Gas Bags - Xonics		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hi - Vol, Sierra 305				X		X	X		X				X			X			X		X		X		X	
LBL Dichotomous Sampler				X		X	X		X				X			X			X		X		X		X	
10 Meter Tower									X		X				X	X	X	X	X			X				
30 Meter Tower		X	X	X	X	X	X	X		X		X	X	X						X	X		X	X	X	X

■ Designates dichotomous/hi-volume sampler site activity. East of the site and just across a road is an abandoned dump. It is occasionally set afire creating a local pollution problem. There is a United States Steel Agri-Chemical plant 330 meters to the northeast and a large electric power plant 2.2 kilometers to the northwest. Several small towns north and south of the site and along the Mississippi River contain assorted heavy industries, extensive railroad and surface vehicle traffic.

Site 105 is located at the Soulard Fire Station in south central St. Louis. The immediate area is predominated by trucking and warehouse operations and vehicular traffic is heavy. Monsanto Chemical Company and Anheuser Busch, Inc. operate plants nearby. To the east and approximately 2.8 kilometers across the Mississippi River are heavy industries including Amax Zinc Company, Cerro Copper Products and a rubber reclamation plant.

Site 106 is located on the grounds of the Missouri Botanical Gardens, adjacent to its power plant. The surrounding area is characterized by large trees, greenhouses and gardens. Interstate Highway 44 lies to the north at a distance of 600 meters and the closest major industry is a steel plant approximately 0.8 kilometers to the west.

Site 108 is on a farm 5.8 kilometers northwest of Granite City, Illinois and several miles east of the Mississippi River. The surrounding land area is utilized for the production of soybeans and wheat. The major pollution source is a steel plant five kilometers south in Granite City. A cement manufacturing plant lies just across the Mississippi River six kilometers to the west.

Site 112 is located on the campus of Washington University, 11 kilometers west of central St. Louis. The surrounding area consists of athletic fields and residential dwellings. Interstate 40 lies two kilometers to the south and there are no heavy or medium industries in the vicinity.

Site 115 is located in Edwardsville, Illinois, 23 kilometers northeast of central St. Louis. The surrounding area is agricultural and produces soybean and wheat as primary crops. Petro-chemical plants are located in two towns six kilometers northwest of the site. Railroad lines lie 200 meters to the northwest.

Site 118 is located on a farm in Columbia, Illinois, 16 kilometers south of central St. Louis. The site is on a river bluff and corn, potatoes and soybeans are the major crops in the area. Nearest major pollutant sources are the petro-chemical plants across the Mississippi river and seven kilometers to the northeast.

Site 120 is located in a light industrial area in Creve Coeur, Missouri, 25 kilometers west of central St. Louis. Immediate surroundings include a number of office buildings and warehouses. Heavy emissions are not reported from any industry in the area. There is, however, heavy traffic flow on Interstate 270 two kilometers to the west and on a major local thoroughfare, 200 meters south of the site.

Site 122 is located on a farm in Jerseyville, Illinois, 45 kilometers north of central St. Louis. Land use in the area is 100 percent agricultural. A field to the east is cultivated while all other surrounding areas serve as pasture land. No major sources of pollution are found in the area. An electric power plant is located 20 kilometers to the south.

Site 124 is located on a farm in Waterloo, Illinois, 39 kilometers south of central St. Louis. The surrounding area is used for the production of soybeans and wheat. There are no major pollution sources in the area.

POLLUTANTS MONITORED WITH DICHOTOMOUS SAMPLER

The Lawrence Berkeley Laboratory (LBL) Automated Dichotomous Sampler, used at 10 sites in the RAMS monitoring network, operates on the principle of virtual impaction.[*] That is, particles are impacted into a slowly pumped void thus eliminating the problem of particle bounce and scouring off collection surfaces. The device collects particles in two size ranges; a cutpoint diameter of 2.4 micrometers divides the particles into fine (< 2.4 µm) and coarse fractions. Size fractionated data is particularly pertinent for human studies research in which attempts are being made to determine toxic threshold levels for aerosol constituents of ambient air.

X-ray fluorescence spectroscopy was employed to perform accurate elemental analysis of LBL particulate samples in both fine and coarse fractions. The composition of a sample is determined by irradiation with a beam of X-rays and observation of the emissions of characteristic K and L X-rays. The procedure is well suited for analysis of elements heavier than Mg in atomic weight and can determine concentration values for a variety of elements in a very short time.

LBL dichotomous samples collected in the RAMS network were analyzed for a total of 26 various trace elements as listed here in order of increasing atomic number. Elements (in both fine and coarse fractions) include: Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Ga, As, Se, Br, Rb, Sr, Cd, Sn, Sb, Ba, Hg and Pb. The beta gauge method was used in assessing total mass for both fine and coarse fraction samples.

F. S. Goulding et al. of Lawrence Berkeley Laboratory estimate that the beta gauge method for aerosol mass determination had an accuracy of 12 $\mu g/m^3$ for 2 hr samples and 2 $\mu g/m^3$ for 12 hr samples. The reproducibility of the X-ray fluorescence measurements was found to be within 5% for major elements.[*]

---

[*] Stevens, Robert K., and Thomas G. Dzubay. "Dichotomous Sampler--A Practical Approach to Aerosol Fractionation and Collection," EPA-600/2-78-112, June 1978.

[**] Goulding F. S., et al. "Aerosol Analysis for the Regional Air Pollution Study," EPA 600/4-78-034, July 1978.

POLLUTANTS MONITORED WITH HIGH VOLUME SAMPLERS

Hi-volume particulate samplers were operated at each of the 10 LBL dichotomous sampler sites in the RAMS network. Hi-volume samples were analyzed for total particulate mass, sulfate and nitrate concentrations.[*] Dichotomous and hi-volume samplers were operated simultaneously side-by-side; pollutant data collected under these sampling conditions have been matched for a comparison of the two different types of instruments.

---

[*] Nelson, E. "Regional Air Pollution Study--High Volume Filter Measurements of Suspended Particulate Matter," EPA-600/4-79-003, January 1979.

SECTION 3

DATA FORMAT

RAPS PARTICULATE DATA TAPES

LBL Dichotomous Sampler Data Tapes

As of March 31, 1977, a total of 31,888 air particulate samples were collected at 10 selected RAMS sites. Filter samples were sent to LBL where analysis was conducted for total mass and for 26 trace elements using beta gauge attenuations and X-ray flourescence procedures (see Section 2, Pollutants Monitored with Dichotomous Sampler). With the generation of results, total mass and elemental data values were written to output records together with identifying parameters (station number, date, sampling start time, sampling interval and particle size). Records have been sorted chronologically by station and output to magnetic tape. All data processing and analysis for this project was performed at NCC in the Research Triangle Park. All program source and runstream listings have been delivered to the Project Officer.

Hi-Volume Sampler Data Tape

RAPS hi-volume sampler data were processed and written to tape by Rockwell International.* Upon completion, data tapes were transmitted to NCC as part of the RAPS archival data base.

Hi-volume sampler data are available for approximately the entire St. Louis sampling period from late March 1975 to March 19[illegible]7.

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* Nelson, E. "Regional Air Pollution Study--High Volume Filter Measurements of Suspended Particulate Matter," EPA-600/4-79-003, January 1979.

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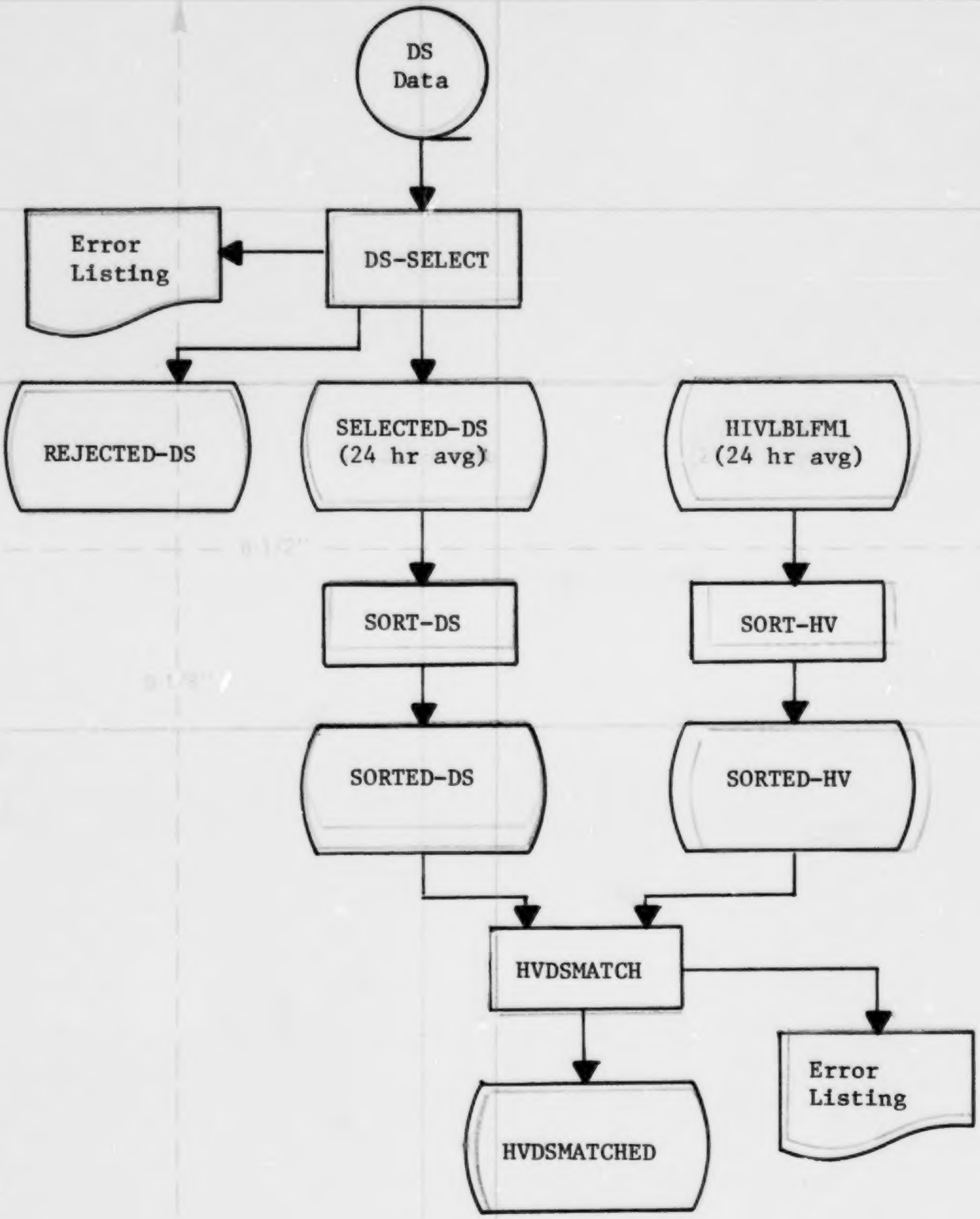
DS
Data
DS-SELECT
Error
Listing
REJECTED-DS
SELECTED-DS
(24 hr avg)
HIVLBLFM1
(24 hr avg)
SORT-DS
SORT-HV
SORTED-DS
SORTED-HV
HVDSMATCH
HVDSMATCHED
Error
Listing

Figure 2. RAPS data processing and analysis system flowchart.

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Records contain identification parameters including: site number, year, month, Julian date, sampling interval (always 24 hours), method, and parameter identification. Pollutants listed by RAPS hi-volume tapes include sulfates, nitrates and total suspended particulates.

REVISION OF PARTICULATE SAMPLER TAPES

LBL Dichotomous Sampler Data Editing and Averaging

Version II of the LBL Dichotomous Sampler (DS) data tape contained several records for each day at each station. A detailed record description of this file is given in Table 2. Many of these records were dummies, i.e., they contained identification information (station, date, interval, size) but no measurements. Before any analysis was attempted these records were edited to remove such dummy records. Since the high volume (HV) instrument collected data for 24-hour intervals, the DS data for fine and coarse fractions were combined and averaged for all intervals on each day. If data for only one fraction during one interval were missing after editing, the entire 24-hour average was rejected. Only messages which actually occur are listed. Data for each day were checked for 25 possible error conditions, but only 9 were detected. A flowchart of this program, DS-SELECT, is shown in Appendix B; the actual errors detected and the number of occurrences are given in Table 3 below. 3 When a record was rejected, the original identification information was printed with the total mass and sulfur measurement and uncertainty. The 24 hr averages for the day were calculated and written to the REJECTED-DS file. Some of these records might be salvaged by determining the correct measurement value and updating the corresponding average. 31,888 records were read and 4,169 were rejected. 4,625 good records with 24 hr averages were written to SELECTED-DS; 1,211 bad records with 24 hr averages were written to REJECTED-DS. Table 4 gives a detailed record description of the files with 24 hr averages of dichotomous sampler data. 4 A sample of the actual error listing is shown in Fig. 3; the complete error listing has been delivered to the Project Officer. Fig 3

Some analyses did not require comparison of dichotomous sampler data with high volume data. For these analyses, a slightly different editing procedure for the dichotomous sampler data was developed and coded in the FORTRAN program EDDS. This procedure edited records for each fraction of each interval independently of other records for that day. Daily averages were not calculated. A detailed record description of the output record is given in Table 5. The only difference between input and output records is that the last 80 bytes of the input record, which never contained any data, were dropped and six flags were added in bytes 43-48 of the unused field BLANK.

RAPS Hi-Volume Data Tape Reformat

SSI staff critically reviewed the RAPS hi-volume data tape and determined that data records required no major editing procedures. The only revision necessary involved the establishment of a crosswalk and transformation of the nine-digit SAROAD site identification number to the three-digit RAPS station code. This three-digit code was appended to each hi-volume data record. As had been performed for dichotomous sampler data, hi-volume data were sorted by STATION and DAY. See Table 6 for a detailed record description. Compared to the DS data the hi-volume (HV) data were quite clean. However, there were a few duplicate records and some records with a sampling interval less than 24 hours. These records were detected by the program that matched dichotomous sampler records with the corresponding hi-volume records. Duplicate records were deleted; measurements for < 24 hr intervals were treated as missing values.

COMBINED HI-VOLUME AND DICHOTOMOUS SAMPLER DATA

Once an edited set of 24-hour averages for the dichotomous sampler was available, it was matched against the hi-volume data set to produce a mass storage file which contained both hi-volume and dichotomous sampler measurements, when available, in each record for a station day. There were 5400 records with at least one valid measurement from either the hi-volume or dichotomous sampler. Since the high-volume instruments were not operated every day, for most of these records there were only dichotomous sampler measurements. There were valid measurements for total mass from both instruments in 1040 records; for sulfate, in 1168 records. Table 7 summarizes the number of data for the hi-volume and for the dichotomous samplers, as well as the dates of the first and last measurement for each instrument. A detailed record description for this file is given in Table 8. A flowchart of this program, HVDSMATCH, is given in Appendix B.

SHEWHART TEST FOR OUTLIERS

The editing tests discussed above removed missing or invalid measurements based on the information within a single record. A comparison of measurements among groups of records can identify suspiciously high or low values, called outliers, which should then be checked for validity. There may be a perfectly good reason for a measurement to suddenly assume an extreme value, but frequently these measurements turn out to be erroneous--the result of a mistake in the sampling procedure or the analysis of the sample. Several procedures[*] are available to identify outliers; the Shewhart test was applied to groups of four matched records to identify outlying total mass or sulfur/sulfate values. When an outlying value was detected for either the hi-volume or dichotomous measurement, the outlier flag (see Table 8) was set for all records in the group and a message was printed. Thirteen percent of the mass pairs were flagged by this test; 24% of the sulfur/sulfate measurements were flagged.

---

[*] Screening Procedures for Ambient Air Quality Data, OAQPS, Research Triangle Park NC 27711, EPA-450/2-78-037, July 1978.

TABLE 2. RECORD DESCRIPTION FOR VERSION II OF LBL DICHOTOMOUS SAMPLER DATA

(Tape reel number 004962, filename LBLDS0279, quarter word mode)

Field Type/Size	Relative Position	Name	Description
I6	1-6	ISTN	RAPS station number
I6	7-12	IYR	Year of the test
I6	13-18	JDAY	Julian day of the test
I6	19-24	ITIME	Starting time of test (24 hr clock)
I6	25-30	INTERV	Duration of the test (hr 100)
I6	31-36	ISIZE	Fraction code (1=fine, 2=coarse)
I6	37-42	ISTAT	Status code
A22	43-64	BLANK	Not used. Should be blanks.
A2	65-66	ELT(1)	Element code. Should be MS for total mass.
F8.1	67-74	ELCON(1)	Element concentration (μg/m^3)
F6.0	75-80	UNCER(1)	Uncertainty in measurement
		- - -	
A2	129-130	ELT(5)	Element code. Should be S for sulfur
F8.1	131-138	ELCON(5)	Element concentration (ng/m^3)
F6.0	139-144	UNCER(5)	Uncertainty in measurement
		- - -	
A2	481-482	ELT(27)	Element code. Should be PB for lead.
F8.1	483-490	ELCON(27)	Element concentration (ng/m^3)
F6.0	491-496	UNCER(27)	Uncertainty in measurement.
A2	497-498	ELT(28)	Dummy code. Should be FB for Front to Back.
F8.1	499-506	ELCON(28)	Front to back correction factor for sulfur.
F6.0	507-512	UNCER(28)	
A2	513-514	ELT(29)	Dummy code. Should be AR for
F8.1	515-522	ELCON(29)	
F6.0	523-528	UNCER(29)	
A2	529-530	ELT(30)	Dummy code. Should be **
F8.1	531-538	ELCON(30)	Not used.
F6.0	539-544	UNCER(30)	Not used.
		- - -	
A2	625-626	ELT(36)	Dummy code. Should be **
F8.1	627-634	ELCON(36)	Not used.
F6.0	635-640	UNCER(36)	Not used.

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TABLE 3. ERROR MESSAGES GENERATED DURING EDITING OF DICHOTOMOUS SAMPLER (DS) DATA

Error 9: DSDATA FOR STATION # DATE # TIME # SIZE # IS OUT OF SEQUENCE. PREVIOUS DATA AND TIME WERE # #.

Cause: This message is printed when records are not sorted by date and time within station.

Action: None other than printed warning.

Number of Occurrences: Once, for a duplicate record.

Error 10: DSDATA FOR STATION # DATE # TIME # SIZE # DOES NOT START AT END OF PREVIOUS INTERVAL # #.

The last two numbers printed are the start time and length of the previous sampling interval.

Cause: The start time of the current interval is not equal to the sum of the previous start time and the previous interval. This test is not made when the date has changed.

Action: The record is rejected.

Number of Occurrences: Once, for a duplicate record.

Error 15: DSDATA FOR STATION # DATE # TIME # SIZE # HAS STATUS CODE 7777

Cause: This status code indicates that valid data are not available for the sampling period.

Action: The record is rejected.

Number of Occurrences: 4169.

Error 16: DSDATA FOR STATION # DATE # TIME # SIZE # TOTAL MASS NOT MEASURED, ISTAT = #.

Cause: The status code indicates that for some reason the total mass was not measured.

Action: A flag is set indicating that the TSP value is missing. This means the 24 hr average is not valid.

Number of Occurrences: 1229.

(continued)

TABLE 3 (continued)

Error 17: DSDATA FOR STATION # DATA # TIME # SIZE # LOW Z ELEMENTS NOT MEASURED, ISTAT = #.

Cause: The status code indicates that the flourescence analysis to measure sulfur was not performed.

Action: A flag is set indicating that the sulfur value is missing. This means the 24 hr average is not valid.

Number of Occurrences: 150.

Error 18: DSDATA FOR STATION # DATE # TIME # SIZE # FRONT TO BACK CORRECTION NOT MADE, ISTAT = #.

Cause: The status code indicates that a necessary correction to the sulfur measurement was not made.

Action: A flag is set indicating that a sulfur value is missing and the 24 hr average is not good.

Number of Occurrences: 239.

Error 24: DSDATA FOR STATION # DATE # TIME # SIZE # SUM OF MASSES # > MS VALUE #.

Cause: The sum of the individual elements in the record is greater than the measured total mass.

Action: None other than warning message.

Number of Occurrences: 918.

Error 25: DSDATA FOR STATION # DATE # TIME # SIZE # SUM OF MASSES # > MS VALUE #.

Cause: The total mass measurement does not agree with the trial sum of the concentrations of six elements suggested by Tom Dzubay:

$$\frac{Si}{273} + \frac{S}{242} + \frac{Ca}{302} + \frac{Ti}{422} + \frac{Br}{41} + \frac{Pb}{164}$$

within either 10 $\mu g/m^3$ or 40%.

Action: A flag is set indicating that the total mass measurement is missing and the 24 hr average is not valid.

Number of Occurrences: 309.

(continued)

TABLE 3 (continued)

Error 26: DSDATA FOR STATION # DATE # TIME # SIZE # SUM OF PERIODS # NOT 2400.

Cause: The sum of the sampling intervals during the day is not 24 hr.

Action: The record is rejected.

Number of Occurrences: One.

```
***** DSDATA FOR STATION  118 DATE 76309 TIME     0 SIZE     2 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   309     0  1200     2  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76313 TIME     0 SIZE     1 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   313     0  1200     1  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76313 TIME     0 SIZE     2 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   313     0  1200     2  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

*** DSDATA FOR STATION  118 DATE 76313 TIME 1200 SIZE     1 TOTAL MASS NOT MEASURED, ISTAT=   1111
*** DSDATA FOR STATION  118 DATE 76313 TIME 1200 SIZE     2 TOTAL MASS NOT MEASURED, ISTAT=    111
*** DSDATA FOR STATION  118 DATE 76320 TIME    0 SIZE     2 TOTAL MASS NOT MEASURED, ISTAT=    111
***** DSDATA FOR STATION  118 DATE 76324 TIME 1200 SIZE     1 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   324  1200  1200     1  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76324 TIME 1200 SIZE     2 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   324  1200  1200     2  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76325 TIME     0 SIZE     1 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   325     0  1200     1  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76325 TIME     0 SIZE     2 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   325     0  1200     2  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76325 TIME 1200 SIZE     1 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   325  1200  1200     1  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76325 TIME 1200 SIZE     2 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   325  1200  1200     2  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76326 TIME     0 SIZE     1 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   326     0  1200     1  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76326 TIME     0 SIZE     2 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   326     0  1200     2  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76326 TIME 1200 SIZE     1 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   326  1200  1200     1  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76326 TIME 1200 SIZE     2 HAS BAD STATUS CODE   7777
***** RECORD REJECTED:    118  1976   326  1200  1200     2  7777
  MS      .00      .00   AL      .00      .00   SI      .00      .00   P      .00      .00   S      .00      .00

***** DSDATA FOR STATION  118 DATE 76327 TIME     0 SIZE     1 HAS BAD STATUS CODE   7777
```

Figure 3 Sample error listing from the program DS-SELECT.

TABLE 4. DETAILED RECORD DESCRIPTION OF 24 HR AVERAGES OF DICHOTOMOUS SAMPLER DATA

(mass storage files RAPS*SELECTED-DS and RAPS*REJECTED-DS)

Field Type/Size	Relative Position	Name	Description
I3	1-3	ISTN	RAPS station number
I5	4-8	JDATE	Julian date (YYDDD)
I4	9-12	INTERV	Minimum sampling interval (hours x 100)
F12.4	13-24	DSMASS	24 hr average for total mass ($\mu g/m^3$)
F12.4	25-36	DSSULF	24 hr average for sulfur ($\mu g/m^3$)
I1	37-37	MISS(1)	Missing value flag for DSMASS (0=OK, 1=missing or invalid)
I1	38-38	MISS(2)	Missing value flag for DSSULF (0=OK, 1=missing or invalid)
I1	39-39	LIMIT(1)	Detection limit flag for DSMASS (0=OK, 1=measurement is below detection limit)
I1	40-40	LIMIT(2)	Detection limit flag for DSSULF (0=OK, 1=measurement is below detection limit)

TABLE 5. RECORD DESCRIPTION OF DICHOTOMOUS SAMPLER DATA
Edited by The Program EDDS

(mass storage file RAPS*EDITED-DS)

Field Type/Size	Relative Position	Name	Description
I6	1-6	ISTN	RAPS station number
I6	7-12	IYR	Year of test
I6	13-18	JDAY	Julian day of test
I6	19-24	ITIME	Starting time of test (24 hr clock)
I6	25-30	INTERV	Duration of the test (in hours X 100)
I6	31-36	ISIZE	Fraction code (1=fine, 2=coarse)
I6	37-42	ISTAT	Status code
I1	43-43	IFLG1	Flag (0=OK, 1=some error detected in this record)
I1	44-44	IFLG2	Flag (0=OK, 1=some or all of data missing)
I1	45-45	IFLG3	Flag (0=mass > sum of individual elements, 1=OK)
I1	46-46	IFLG4	Flag (0=OK, 1=this is a generated record)
I1	47-47	IFLG5	Flag (0=OK, 1=status field inconsistent with data)
I1	48-48	IFLG6	Flag (0=bad record, 1=record contains valid data)
A16	49-64	BLANK	Not used. Should be blanks.
A2	65-66	ELT(1)	Element code. Should be MS for total mass.
F8.1	67-74	ELCON(1)	Element concentration (μg/m^3)
F6.0	75-80	UNCER(1)	Uncertainty in concentration.
		-	
		-	
		-	
A2	545-546	ELT(31)	Dummy code. Should be **.
F8.1	547-554	ELCON(31)	Not used.
F6.0	555-560	UNCER(31)	Not used.

TABLE 6. RECORD DESCRIPTION OF HI-VOLUME SAMPLER DATA
(in mass storage filename RAPS*HIVLBLFM1)

Field Type/Size	Relative Position	Name	Description
I1	1-1	FLG	Card format identification
I9	2-10	LOCATN	State, area, site codes
A1	11-11	EP	Agency type
I2	12-13	TYP	Project classification
I1	14-14	INT	Sampling period code (should be 7)
I6	15-20	IYYMMDD	Date of sample
I2	21-22	ISTART	Sampling start time
I5	23-27	IPOLL(1)	Pollutant ID. Should be
I2	28-29	MTH(1)	Sampling method
I2	30-31	IUNIT(1)	Units code
I1	32-32	NEC(1)	Decimal locator
F5.1	33-37	RMSR(1)	Total mass measurement (μg/m^3)
	38	-	
		-	
		-	
F5.1	48	RMSR(2)	Sulfate measurement (μg/m^3)
		-	
		-	
		-	
F5.1	63-67	RMSR(3)	Nitrate measurement (μg/m^3)
I6	68-73	ISIX	
I3	74-76	IPERD	
F6.1	77-82	SAMPVO	Sample volume
I3	83-85	JDAY	Julian day
I3	86-88	NRPSTA	RAPS station number

TABLE 7. SUMMARY OF DATA FOR HI VOLUME AND DICHOTOMOUS SAMPLERS

	Dichotomous				Hi-Volume		
Station	No. of Records	First Date	Last Date	No. of Days	No. of Records	First Date	Last Date
103	5813	75167	77091	486	223	75075	77088
105	5853	75167	77090	517	227	75075	77088
106	2032	75157	76244	397	215	75075	77088
108	2691	75165	76033	398	233	75072	77088
112	3161	75160	77041	513	233	75075	77088
115	2671	75171	77026	472	222	75072	77088
118	2605	75155	77034	430	226	75084	77088
120	2541	75174	77031	456	200	75067	77088
122	2544	75142	77016	436	234	75072	77088
124	1977	75143	76238	374	180	75075	77043
All	31888	75142	77091	4480	2193	75067	77088

TABLE 8. RECORD DESCRIPTION OF COMBINED HI-VOLUME AND DICHOTOMOUS SAMPLER DATA
(mass storage filename RAPS*HVDSMATCHED)

Field Type/Size	Relative Position	Name	Description
I3	1-3	ISTN	RAPS station number
I5	4-8	JDATE	Julian date (YYDDD)
I4	9-12	IDSINT	Dichotomous sampling interval (hr X 100, minimum if this varies during day)
F6.1	13-18	HVMASS	Hi-volume mass measurement ($\mu g/m^3$)
F6.1	19-24	HVSO4	Hi-volume sulfate measurement ($\mu g/m^3$)
F6.1	25-30	HVNO3	Hi-volume nitrate measurement ($\mu g/m^3$)
F12.1	31-42	DSMASS	Dichotomous mass measurement ($\mu g/m^3$)
F12.1	43-54	DSSULF	Dichotomous sulfur measurement ($\mu g/m^3$)
I1	55-55	MISS(1,1)	Missing value flag for HUMASS (0=OK, 1=missing or invalid)
I1	56-56	MISS(1,2)	Missing value flag for HVSO4 (0=OK, 1=missing or invalid)
I1	57-57	MISS(1,3)	Missing value flag for HVNO3 (0=OK, 1=missing or invalid)
I1	58-58	MISS(2,1)	Missing value flag for DSMASS (0=OK, 1=missing or invalid)
I1	59-59	MISS(2,2)	Missing value flag for DSSULF (0=OK, 1=missing or invalid)
I1	60-60	LIMIT(1)	Detection limit flag for DSMASS (0=OK, 1=measurement is below detection limit)
I1	61-61	LIMIT(2)	Detection limit flag for DSSULF (0=OK, 1=measurement is below detection limit)
I1	62-62	LIER(1)	Outlier flag for DSMASS. Set by pgm. SHEWHART (0=OK, 1=outlier)
I1	63-63	LIER(2)	Outlier flag for DSSULF. Set by pgm. SHEWHART (0=OK, 1=outlier)

SECTION 4

ANALYSIS

A variety of analyses, as requested by the contract, were performed once the data had been edited and matched. Figure 4 is a system flowchart of the data files and programs used for these analyses. Source listings of all analysis programs have been delivered to the Project Officer. A brief description of each task follows.

TIME-SERIES PLOTS SHOWING MASS AND SULFATE FOR HIGH VOLUME AND DICHOTOMOUS SAMPLERS

A FORTRAN program utilizing CALCOMP subroutines was developed to read the file HVDSMATCHED and plot the high volume measurements as well as the dichotomous sampler 24 hr averages by quarter. The dichotomous sulfur measurement was mutliplied by 3 to get the sulfate equivalent for comparison with the high volume sulfate measurement.* Values flagged as missing were not plotted. Figure 5 shows a sample plot for station 103 during the first quarter of 1976; plots for all stations and quarters are presented in Appendix C. A solid (dashed) line connects the dichotomous (high volume) points unless there is a missing point. Uniform limits were chosen for all plots to facilitate comparison and to produce a reasonably expanded view of the data; for points which fell above these limits, a message giving the coordinates was printed, but these points are excluded from the figures.

COMPARISON OF HIGH-VOLUME WITH DICHOTOMOUS SAMPLER DATA

For several of the analyses required, the Statistical Package for the Social Sciences (SPSS) provides standard procedures.** An SPSS program, TASK2A, was written to read the file HVDSMATCHED, to calculate the dichotomous sulfate equivalent (3 times the sulfur measurement), to compute the ratio (HV/DS) of the mass and the sulfate data, to produce descriptive statistics for all variables, and to create an SPSS file for further statistical analyses.

---

* Stevens, Robert K., et al. "Sampling and Analysis of Atmospheric Sulfates and Related Species, " Atmospheric Environment 12, 55 (1978).

** Nie, N. H., et al. Statistical Package for the Social Sciences, Second Edition. McGraw-Hill, 1975.

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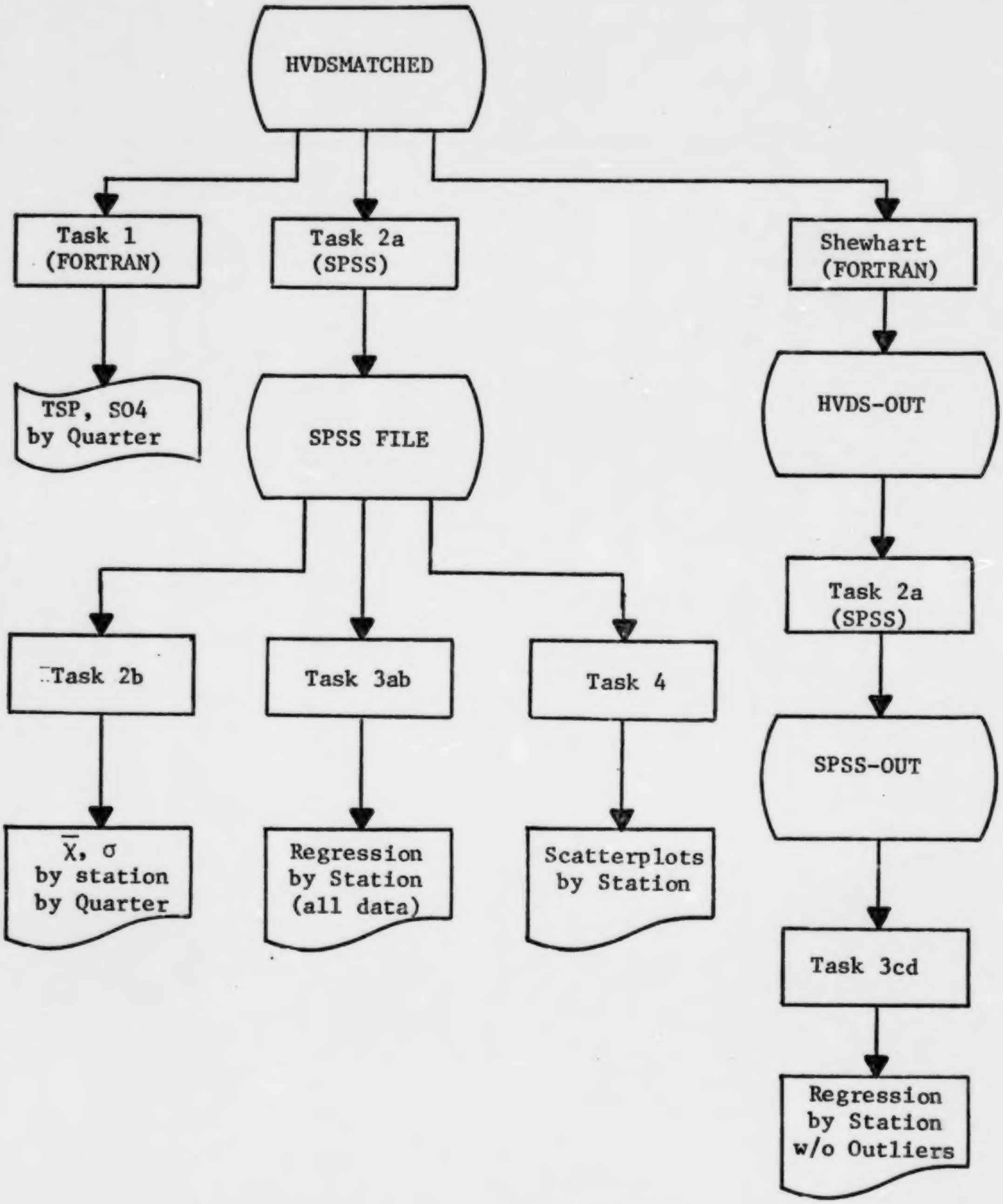
HVDSMATCHED
Task 1 (FORTRAN)
Task 2a (SPSS)
Shewhart (FORTRAN)
TSP, SO4 by Quarter
SPSS FILE
HVDS-OUT
Task 2a (SPSS)
Task 2b
Task 3ab
Task 4
SPSS-OUT
X̄, σ by station by Quarter
Regression by Station (all data)
Scatterplots by Station
Task 3cd
Regression by Station w/o Outliers

Figure 4. RAPS data analysis for comparison of high volume with dichotomous sampler data.

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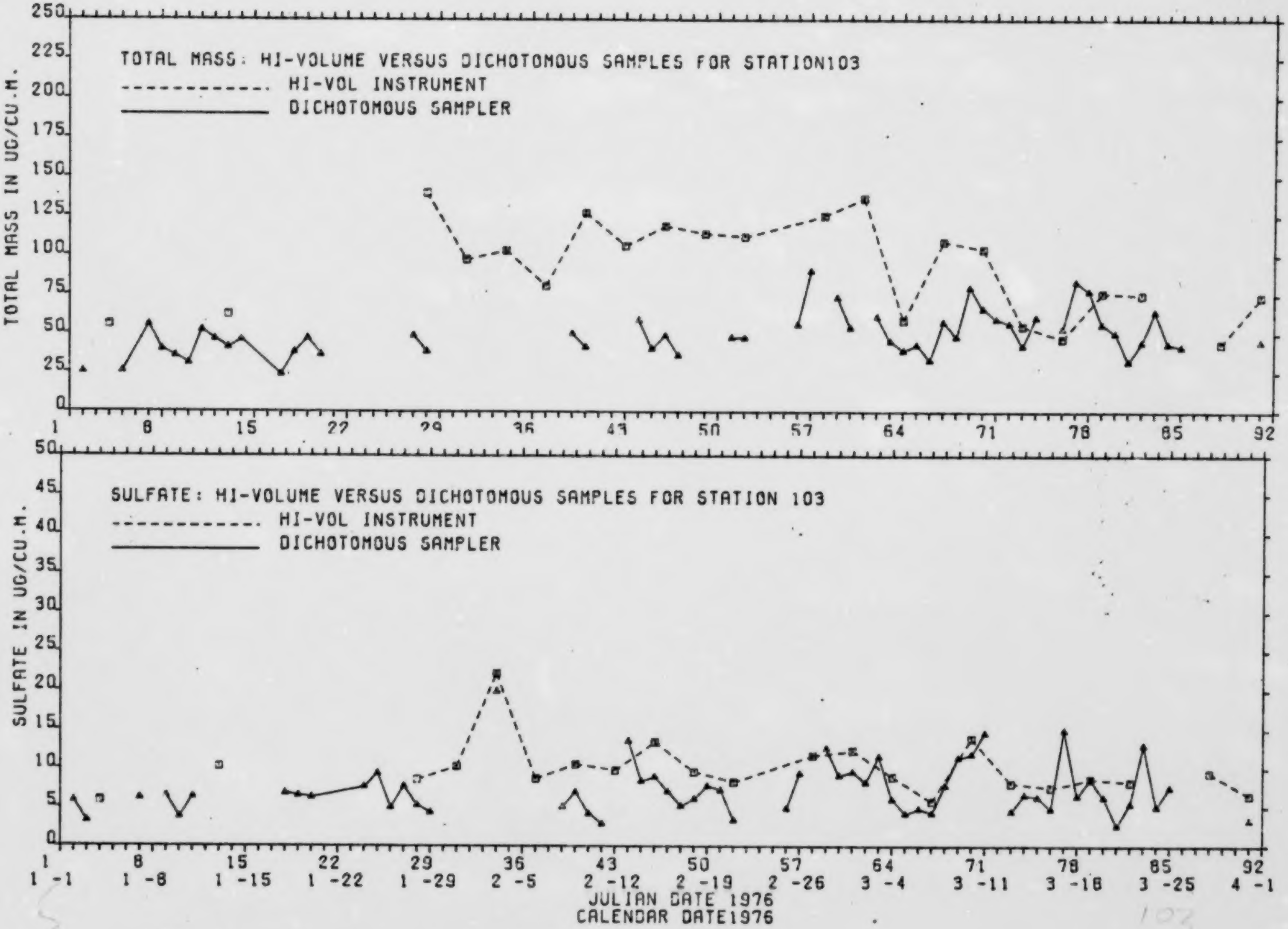

Figure 5. **Comparison of high volume versus dichotomous samples at station** 103.

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Mean and Standard Deviation of the Ratio of Hi-Volume to Dichotomous Measurements for Mass and Sulfate

An SPSS program, TASK2B, was written to determine the mean and standard deviation of the mass and sulfate data by station by quarter. These statistics were also calculated for the ratios of hi-volume to dichotomous measurements. Only days with valid measurements for both instruments contribute to these ratios. Table 9 illustrates these statistics for station 103; tables for all stations can be found in Appendix D. 9

Linear Regression of Hi-Volume vs. Dichotomous Measurements

The SPSS procedure REGRESSION was used in a program called TASK3 to determine the slope (B) and the intercept (A) of the best fit least square line [HV = A + (B)(DS)] for the data from each station. The Pearson product-moment correlation coefficient was also calculated. Table 10 shows the results for total mass; Table 11, for sulfate. This analysis was repeated, eliminating the measurements flagged as outliers by the Shewhart test. Tables 12 and 13 show no significant improvement in the correlations when outliers are excluded. 10 11 12 13

Scatterplots Showing Hi-Volume vs. Dichotomous Measurements for Mass and Sulfate

An SPSS program, TASK4, was used to produce two scatterplots for each station. The hi-volume value was used as the y-coordinate; the dichotomous value, as the x-coordinate. Again, uniform limits were chosen to provide a reasonably expanded picture of the data for all mass and for all sulfate plots. Sample plots for station 103 are shown in Figs. 6 and 7. Plots for all stations are presented in Appendix E. The equation of the regression line and the correlation coefficient from the analysis above are shown at the bottom of the figures.

ANALYSIS OF DICHOTOMOUS SAMPLER DATA BY FRACTIONS

Several analyses were requested using only the dichotomous sampler data for each fraction of selected elements. For these analyses the dichotomous sampler data were not averaged; fractions were compared for each interval with

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TABLE 9. QUARTERLY HIVOLUME TO DICHOTOMOUS 24 HR AVERAGES
STATION 103

Pollutant	Year	Qtr.	Hivolume No. of cases	Hivolume Mean*	Hivolume std. dev.	Dichotomous No. of cases	Dichotomous Mean*	Dichotomous std. dev.	Ratio No. of cases	Ratio Mean	Ratio std. dev.
Mass	1975	2	16	102.6	32.8	13	64.7	20.9	4	2.23	0.38
		3	28	97.5	39.5	73	68.0	30.7	16	1.62	0.95
		4	28	93.1	36.8	83	47.2	25.1	24	2.39	1.06
	1976	1	23	90.4	30.1	66	45.1	16.5	17	2.00	0.70
		2	21	94.5	37.7	76	71.3	34.9	16	1.38	0.44
		3	25	101.4	28.1	48	71.3	27.3	12	1.49	0.33
		4	27	88.0	39.2	63	48.0	27.9	16	2.06	0.68
	1977	1	27	72.1	34.5	63	33.2	18.4	15	2.18	0.94
	All	All	197	91.9	35.7	486	54.9	29.8	120	1.93	0.85
Sulfate	1975	2	16	12.20	7.76	13	18.84	11.06	4	0.97	0.27
		3	28	14.13	6.62	73	14.66	9.85	16	1.59	1.42
		4	28	12.04	5.57	83	7.52	3.63	23	1.69	0.61
	1976	1	23	10.19	3.71	66	6.91	3.44	18	1.58	0.37
		2	21	13.31	7.11	76	12.33	9.13	18	1.23	0.26
		3	25	15.32	5.45	48	15.65	8.40	12	1.19	0.29
		4	27	9.81	4.13	63	7.41	4.49	21	1.44	0.40
		1	28	9.90	3.40	63	7.00	2.68	20	1.55	0.47
	All	All	198	12.17	5.84	486	10.28	7.63	132	1.47	0.65

* Units are ug/m^3

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TABLE 10. LINEAR REGRESSION ANALYSIS HI-VOLUME MASS VS. DICHOTOMOUS TOTAL MASS

Station Number	No. of Cases	Mean HV/DS Ratio	S.D. HV/DS Ratio	Corr. Coeff.	Intercept* ($\mu g/m^3$)	95% Conf. Interval	Slope#	95% Conf. Interval
103	120	1.93	0.85	0.637	43.99	-16.28→104.26	0.902	0.703→1.101
105	118	2.04	0.78	0.646	49.46	+ 0.24→ 98.68	0.786	0.615→0.957
106	95	1.76	0.82	0.666	29.40	-20.88→ 79.68	0.967	0.744→1.190
108	91	1.96	1.09	0.708	31.50	-24.23→ 87.23	1.051	0.830→1.272
112	115	1.73	0.71	0.722	21.11	-37.26→ 79.48	1.143	0.938→1.348
115	111	1.57	0.52	0.860	14.33	-12.56→ 41.22	1.074	0.953→1.195
118	104	2.18	1.33	0.514	37.02	-15.01→ 89.05	0.809	0.544→1.074
120	97	1.71	1.09	0.377	31.06	-28.80→ 90.92	0.682	0.340→1.024
122	112	1.72	0.92	0.594	22.27	-26.49→ 71.03	0.861	0.640→1.082
124	77	2.17	1.32	0.433	28.33	-23.56→ 80.22	0.919	0.478→1.360
All	1040	1.869	0.970	0.671	27.04	-25.81→ 79.89	1.020	0.951→1.089

* The intercept of the regression line is the predicted value of the HIVOL mass when the dichotomous sampler mass is zero

# The slope of the regression line is the predicted change in HIVOL mass for unit change in dichotomous sampler mass

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TABLE 11. LINEAR REGRESSION ANALYSIS
HI-VOLUME SULFATE VS. DICHOTOMOUS SULFATE

Station Number	No. of Cases	Mean HV/DS Ratio	S.D. HV/DS Ratio	Corr. Coeff.	Intercept* ($\mu g/m^3$)	95% Conf. Interval	Slope#	95% Conf. Interval
103	132	1.47	0.65	0.857	4.574	-1.893→11.041	0.791	0.708→0.874
105	141	1.39	0.34	0.964	2.815	-0.796→ 6.426	0.939	0.896→0.982
106	103	1.35	0.45	0.937	2.983	-3.435→ 9.401	0.916	0.848→0.984
108	105	1.47	0.66	0.811	4.647	-3.990→13.284	0.778	0.668→0.888
112	143	1.39	0.83	0.818	2.927	-6.576→12.430	0.928	0.819→1.037
115	129	1.35	0.46	0.904	3.418	-1.979→ 8.815	0.808	0.741→0.875
118	110	1.53	0.75	0.854	4.725	-1.870→11.320	0.706	0.624→0.788
120	106	1.80	1.35	0.637	3.705	-9.418→16.828	0.949	0.725→1.173
122	121	1.53	0.66	0.702	3.711	-8.715→16.137	0.888	0.724→1.052
124	78	1.45	0.55	0.952	2.695	-2.932→ 8.322	0.951	0.881→1.021
All	1168	1.47	0.72	0.838	3.620	-4.481→11.721	0.864	0.832→0.896

* The intercept of the regression line is the predicted value of the HIVOL mass when the dichotomous sampler mass is zero

# The slope of the regression line is the predicted change in HIVOL mass for unit change in dichotomous sampler mass

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TABLE 12. LINEAR REGRESSION ANALYSIS

HIVOLUME MASS VS. DICHOTOMOUS TOTAL MASS (EXCLUDING OUTLIERS)

Station Number	No. of cases	Mean HV/DS ratio	S.D. HV/DS ratio	Corr. Coeff.	Intercept* ($\mu g/m^3$)	95% Conf. Interval	Slope#	95% Conf. Interval
103	109	1.97	0.84	.651	41.86	-17.18→100.9	0.963	0.747→1.179
105	102	1.41	0.34	.617	41.15	- 9.41→91.71	1.015	0.757→1.273
106	77	1.78	0.59	.770	19.97	-21.11→61.05	1.193	0.966→1.420
108	82	1.91	1.12	.698	32.40	-23.54→88.34	1.008	0.779→1.237
112	68	1.78	0.58	.793	18.80	- 8.99→46.59	1.082	0.878→1.286
115	104	1.57	0.53	.863	13.37	-11.90→38.64	1.098	0.973→1.223
118	83	2.19	1.19	.518	31.21	-13.64→76.04	0.958	0.607→1.309
120	88	1.74	1.14	.363	33.17	-30.34→96.68	0.662	0.298→1.026
122	79	1.82	0.73	.858	16.13	- 9.00→41.26	1.111	0.959→1.263
124	69	2.25	1.36	.440	24.83	-30.33→79.99	1.091	0.548→1.634
All	861	1.91	0.93	.695	23.96	-23.55→71.47	1.110	1.033→1.187

* The intercept of the regression line is the predicted value of the HIVOL mass when the dichotomous sampler mass is zero

# The slope of the regression line is the predicted change in HIVOL mass for unit change in dichotomous sampler mass

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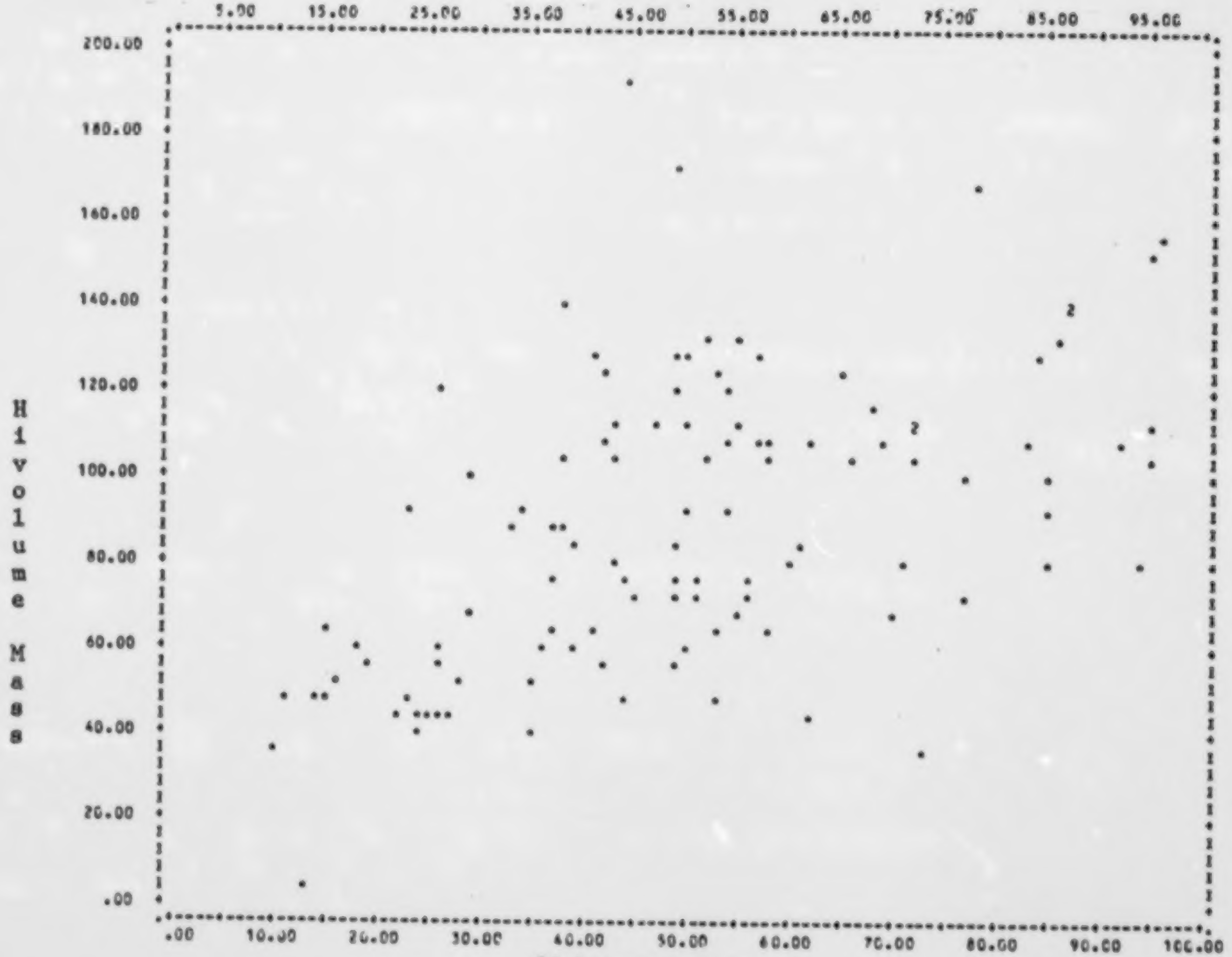
TABLE 13. LINEAR REGRESSION ANALYSIS

HIVOLUME SULFATE VS. DICHOTOMOUS SULFATE (EXCLUDING OUTLIERS)

Station Number	No. of cases	Mean HV/DS ratio	S.D. HV/DS ratio	Corr. Coeff.	Intercept* ($\mu g/m^3$)	95% Conf. Interval	Slope#	95% Conf. Interval
103	86	1.58	0.74	.741	8.024	0.521→15.527	0.792	0.636→0.948
105	93	1.42	0.34	.905	7.697	4.337→11.057	0.864	0.779→0.949
106	51	1.45	0.40	.889	6.889	4.111→ 9.667	0.734	0.626→0.842
108	72	1.51	0.67	.875	9.192	1.974→16.410	0.987	0.947→1.027
112	74	1.37	0.37	.838	7.169	1.865→12.473	1.019	0.863→1.175
115	99	1.38	0.48	.899	8.637	3.429→13.845	0.852	0.769→0.963
118	76	1.62	0.81	.585	6.470	0.035→12.905	0.661	0.449→0.873
120	62	1.97	1.62	.522	6.299	-0.136→12.734	0.907	0.525→0.949
122	68	1.60	0.53	.889	5.813	2.282→ 9.344	0.992	0.866→1.118
124	68	1.46	0.57	.816	7.350	2.601→12.099	0.739	0.609→0.869
All	749	1.53	0.73	.798	7.453	1.387→13.519	0.871	0.824→0.918

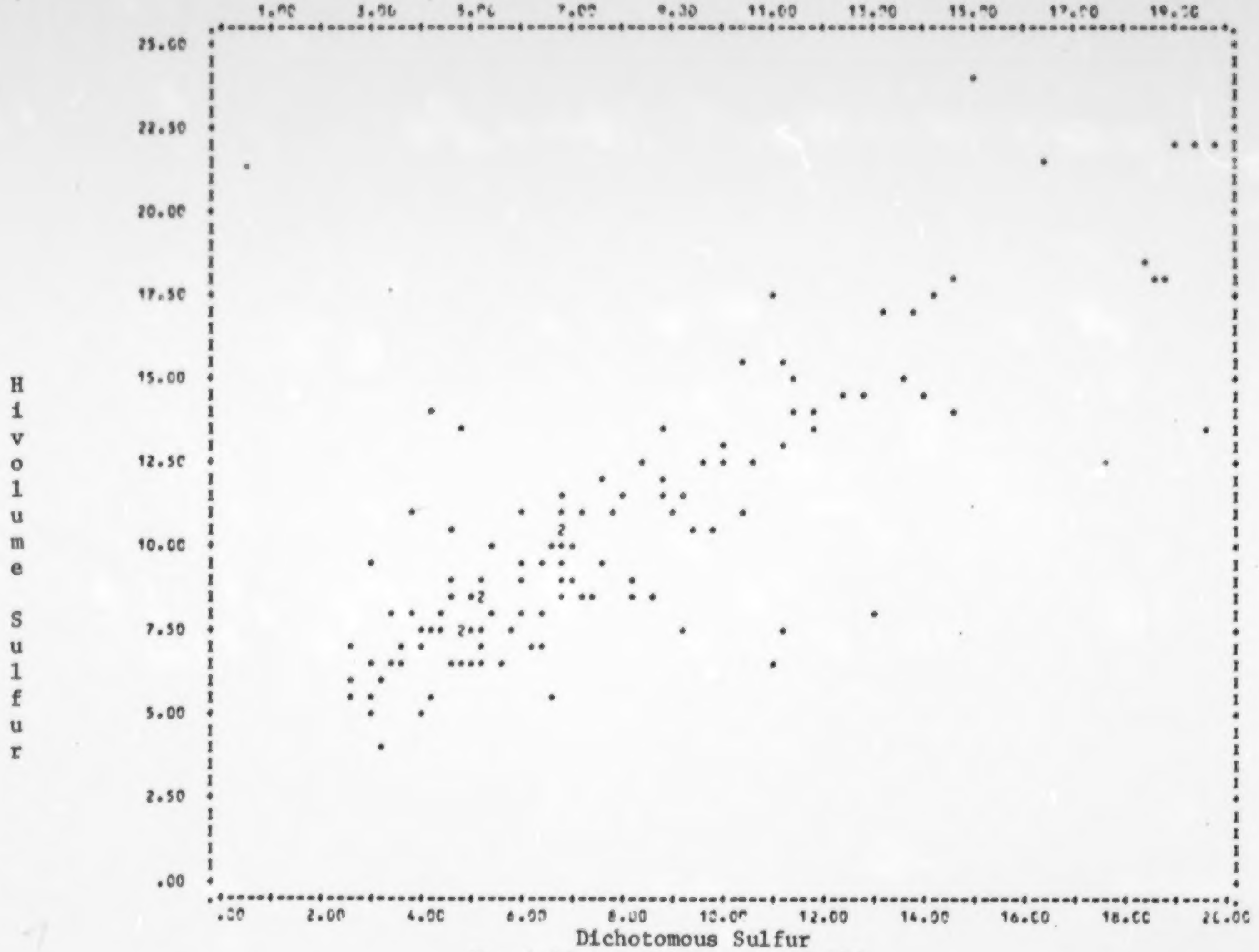
* The intercept of the regression line is the predicted value of the HIVOL mass when the dichotomous sampler mass is zero

# The slope of the regression line is the predicted change in HIVOL mass for unit change in dichotomous sampler mass



Y = 44.0 + 0.902X   R = 0.637

Figure 6   **Comparison of high volume and dichotomous sampler mass measurements at station 103.**



Y = 4.57 + 0.791X   R = 0.857

Figure 7 Comparison of high volume and dichotomous sampler sulfur measurements at station 103.

two valid measurements. Figure 8 is a flowchart of the data processing and analysis programs used for these comparisons. 8

Time-Series Plots of Mass, Sulfur, and Lead in the Fine and Coarse Fractions

A FORTRAN program, called TSPLOT, utilizing CALCOMP subroutines was developed to read the file EDITED-DS and plot the mass, sulfur, and lead measurements for each fraction for each sampling interval. All of these plots have been delivered to the Project Officer. The coarse (fine) fraction points are connected with a solid (dashed) line except when data for an interval are missing. Measurements below the detection limit are indicated by an asterisk.

Frequency Distribtuion of the Fine:Total Ratio for Mass, Sulfur, and Lead

Figure 9 shows histograms of the ratio of the fine fraction to the total (fine + coarse) measurement for mass, sulfur, and lead from station 103. Histograms for all stations, produced by the FORTRAN program TASK6A, may be found in Appendix F. 7

Table 14 gives the means and standard deviations of the fine:total ratio for mass, sulfur, and lead for station 103. Tables for all stations may also be found in Appendix F. The SPSS program TASK6B was used to calculate these statistics. Records with invalid or missing data were ignored. 14

Descriptive Statistics for Selected Elements in Both Fractions and Correlation Coefficients Between Fractions

An SPSS program, TASK7A, was developed to determine the maximum, minimum, mean, and standard deviation for the fine and coarse fractions of each element by station. The results for station 103 are presented in Table 15; tables for all stations are in Appendix G. Statistics for elements K, Ca, Al, Si have been suppressed because we were advised by the Project Officer that some of the measurements in 1975 were invalid. 15

The correlation coefficients between each fraction of each element were also calculated by the SPSS program TASK7B; these results are also shown in

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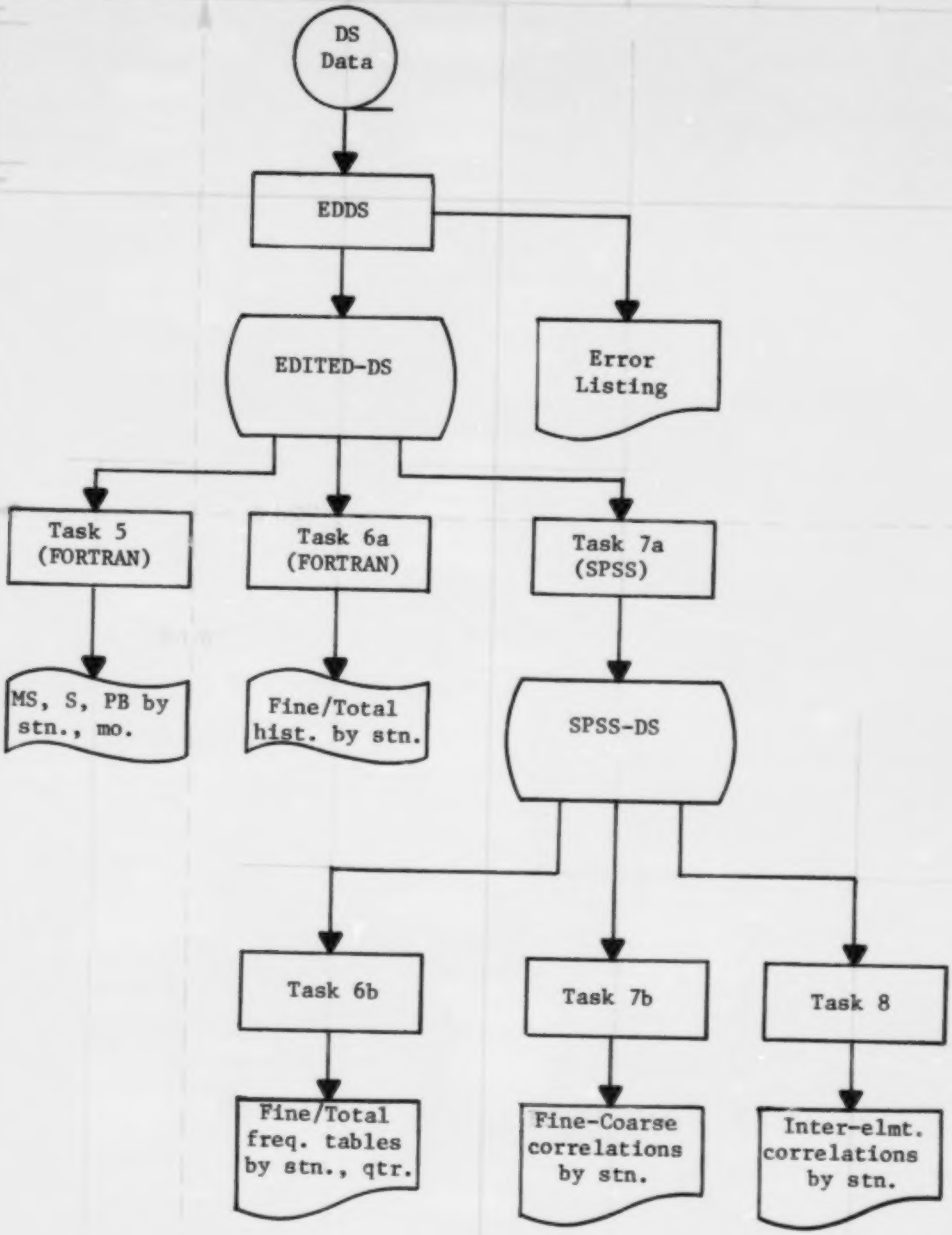
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Error Listing
Task 5 (FORTRAN)
Task 6a (FORTRAN)
Task 7a (SPSS)
MS, S, PB by stn., mo.
Fine/Total hist. by stn.
SPSS-DS
Task 6b
Task 7b
Task 8
Fine/Total freq. tables by stn., qtr.
Fine-Coarse correlations by stn.
Inter-elmt. correlations by stn.

Figure 8. RAPS data processing and analysis for dichotomous sampler data.

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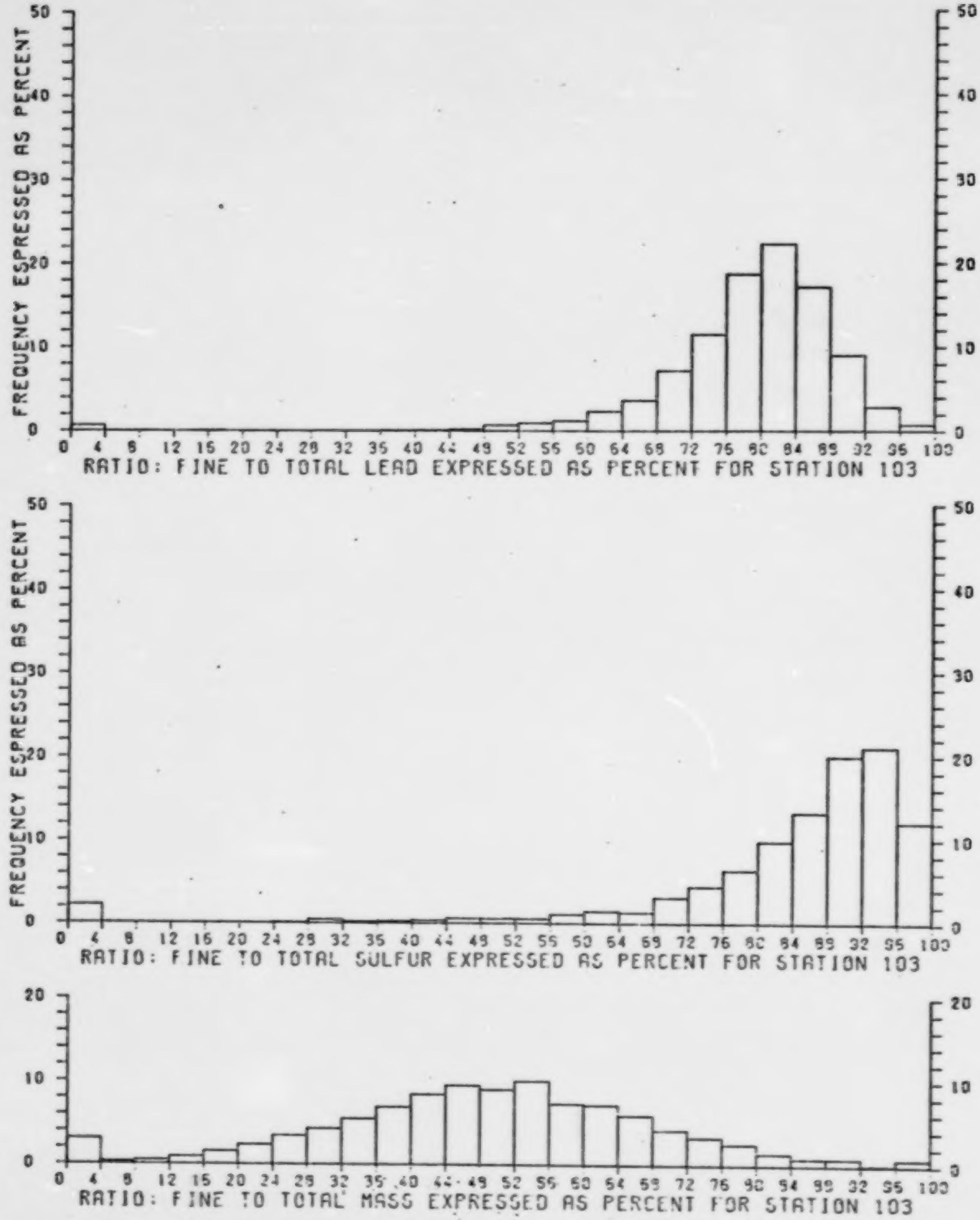

Figure 9. Frequency distribution of fine:total ratio for selected elements

TABLE 14. MEANS AND STANDARD DEVIATIONS OF THE RATIOS OF FINE FRACTION TO TOTAL, FOR MASS, SULFUR, AND LEAD
STATION 103

		Mass		Sulfur		Lead	
Year	Qtr.	No. of cases	$\bar{\rho}^* \pm \alpha^\#$	No. of cases	$\bar{\rho}^* \pm \alpha^\#$	No. of cases	$\bar{\rho}^* \pm \alpha^\#$
1975	2	55	.64±.14	54	.91±.06	53	.83±.07
	3	498	.50±.16	471	.90±.08	496	.78±.08
	4	322	.59±.16	290	.88±.11	328	.81±.09
1976	1	303	.47±.16	295	.85±.13	298	.78±.11
	2	300	.47±.13	333	.82±.14	334	.77±.08
	3	262	.48±.15	269	.86±.12	269	.79±.06
	4	251	.45±.17	265	.80±.14	265	.80±.08
1977	1	217	.51±.16	227	.85±.12	228	.80±.09
	All	2201	.50±.16	2206	.86±.12	2273	.79±.09

* $\bar{\rho}$ is the average of the ratios, ρ, of fine fraction measurement to total measurement (fine plus coarse fraction).

# α is the standard deviation of ρ.

Table 15 and Appendix G. Only intervals where valid data from both fractions were present were used in these calculations.

Correlation Coefficients Between Selected Elements

Another SPSS program, TASK8, was written to compute the correlation coefficients between selected elements by station for both the fine and the coarse fractions. Table 16 displays these correlations for station 103; tables for all stations are in Appendix H. Each cell contains the correlation coefficient, number of cases, and level of significance for a comparative analysis of total mass and sulfate measurements by both types of instruments. Data for the coarse fraction are presented above the diagonal; the fine fraction, below the diagonal.

TABLE 15. RELATIONSHIPS BETWEEN FINE AND COARSE FRACTIONS FOR MASS AND 23 ELEMENTS (STATION 103)

	Fine fraction					Fine-coarse correlation			Coarse fraction				
Elmt.	No. of Cases	Max.*	Min.#	Mean*	Std.* dev.	No. of Cases	Coeff.	Sig.	No. of Cases	Max.*	Min.#	Mean*	Std.* dev.
MS	2227	161.9	1.000	30.07	19.83	2201	.486	.000	2262	194.4	1.500	31.29	21.78
P	1603	1.24	0.000	0.075	0.129	1575	.296	.000	2206	17.06	0.600	0.331	0.966
S	2251	22.05	0.150	3.317	2.822	2206	.142	.000	2219	18.73	1.600	0.501	0.857
Cl	1872	5.76	0.400	0.288	0.375	1485	.337	.000	1662	10.45	1.900	0.471	0.708
Ti	1429	0.89	0.100	0.031	0.055	1403	.844	.000	2013	5.92	0.200	0.143	0.247
V	1315	0.06	0.100	0.008	0.007	923	.249	.000	1314	0.10	0.100	0.010	0.009
Cr	1457	0.07	0.400	0.009	0.008	1243	.304	.000	1582	0.80	0.100	0.017	0.031
Mn	1889	0.24	0.400	0.018	0.020	1849	.403	.000	2062	0.36	0.400	0.046	0.040
Fe	2284	1.99	5.000	0.213	0.196	2278	.663	.000	2287	12.60	66.800	1.539	1.221
Ni	1633	0.05	0.400	0.005	0.005	1413	.464	.000	1654	0.06	0.100	0.005	0.005
Cu	1508	1.95	0.400	0.064	0.157	1265	.569	.000	1484	0.57	0.100	0.022	0.040
Zn	2229	3.08	0.400	0.130	0.228	2158	.636	.000	2201	6.91	0.100	0.116	0.272
Ga	505	0.01	0.400	0.002	0.001	224	.364	.000	775	0.02	0.300	0.002	0.001
As	1141	0.13	0.400	0.006	0.009	598	.509	.000	914	0.19	0.400	0.005	0.009
Se	1915	0.07	0.400	0.004	0.005	1004	.138	.000	1057	0.01	0.100	0.001	0.001
Br	2283	2.56	1.500	0.143	0.226	1972	.814	.000	1981	0.33	0.100	0.028	0.031
Rb	1014	0.01	0.400	0.002	0.002	867	.577	.000	1688	0.02	0.200	0.003	0.003
Sr	1237	0.08	0.400	0.003	0.004	1209	.245	.000	2173	0.13	0.400	0.010	0.009
Cd	1432	0.41	0.400	0.009	0.021	705	.505	.000	913	0.21	0.100	0.012	0.012
Sn	1702	0.31	0.400	0.014	0.025	668	.312	.000	789	0.10	0.100	0.007	0.007
Sb	1534	0.32	0.400	0.005	0.010	810	.133	.000	1065	0.13	0.100	0.006	0.006
Ba	1410	0.20	0.400	0.011	0.015	1260	.597	.000	2011	0.47	0.100	0.034	0.034
Hg	1188	0.05	0.400	0.003	0.005	731	.268	.000	1035	0.02	0.400	0.002	0.002
Pb	2284	6.93	22.700	0.586	0.698	2273	.754	.000	2282	2.77	1.800	0.176	0.176

* Units are $\mu g/m^3$ # Units are ng/m^3

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TABLE 16. CORRELATION COEFFICIENTS AMONG ELEMENTS COARSE FRACTION ABOVE THE DIAGONAL, FINE FRACTION BELOW THE DIAGONAL, FOR STATION 103

	MS	S	TI	FE	ZN	BR	PB
MS	1.000 0 *****	.5222 2319 .000	.3383 2100 .000	.7767 2388 .000	.2700 2295 .000	.4521 2073 .000	.4029 2383 .000
S	.7381 2396 .000	1.000 0 *****	.1589 2154 .000	.3726 2451 .000	.1917 2360 .000	.2674 2138 .000	.2543 2446 .000
TI	.2020 1502 .000	.1249 1547 .000	1.000 0 *****	.4489 2206 .000	.2038 2156 .000	.2342 2005 .000	.4296 2205 .000
FE	.3320 2426 .000	.1817 2502 .000	.3339 1575 .000	1.000 0 *****	.3105 2419 .000	.5491 2199 .000	.5274 2522 .000
ZN	.2194 2357 .000	.1462 2421 .000	.2711 1555 .000	.3927 2455 .000	1.000 0 *****	.2666 2139 .000	.4209 2417 .000
BR	.3719 2425 .000	.0988 2501 .000	.1031 1575 .000	.3320 2535 .000	.1297 2454 .000	1.000 0 *****	.7166 2199 .000
PB	.4633 2426 .000	.1954 2502 .000	.3372 1575 .000	.4381 2536 .000	.3883 2455 .000	.8478 2535 .000	1.000 0 *****

Each Cell Contains: Correlation Coefficient
Number of Cases
Significance

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SECTION 5

RESULTS

The most important aspect of this project is the comparison of high volume with dichotomous measurements. Unfortunately, there is no simple relationship between measurements of the same pollutant by the two different types of instruments operated simultaneously at the same sites. For both total mass and sulfate, the high volume instrument measures significantly greater pollution than does the dichotomous sampler. Overall, the high volume to dichotomous ratio is 1.87 ± .03 for total mass, 1.47 ± .02 for sulfate. These differences are not unexpected, although the magnitude is somewhat larger than has been previously observed.[*] The central sites have the largest concentration of both mass and sulfate. There are no significant differences between stations in the HV/DS ratio for either mass or sulfate. In general, the mass measurements are highest during the second quarter (April-June); the sulfate, during the third (July-September).

The regression analysis shows that the relationship between the two instruments is not a linear one. For total mass the overall correlation coefficient is only 0.671, varying from 0.377 at station 120 to 0.860 at station 115. At each station except 105, the slope is consistent with unity and the intercept is consistent with zero.

The correlation coefficients for sulfate are higher, with an overall value of 0.838, varying from 0.637 at station 120 to 0.964 at station 105. Again, the intercepts for each station are consistent with zero, but for most stations the 95% confidence interval for the slope is below unity.

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[*] Camp, David C., et al. "Intercomparison of Samplers Used in the Determination of Aerosol Composition," EPA-600/7-78-118, July 1978.

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The lack of a simple relationship between the measurements by high volume and dichotomous samplers may be at least partially explained by differences in the design of the two instruments. The high volume instrument has essentially no upper cutoff for particle size, but the dichotomous sampler rejects particles with a diameter greater than about 20 μm. No particle size distribution data, other than that provided by the fine and coarse fractions of the dichotomous sampler, were collected by the RAPS instruments. However, previous studies in other areas have shown that aerosol particles have a biomodal size distribution, with different sources for each mode.[*] The small particle mode--<10 μm in diameter--is primarily due to condensation of stack gases. The large particle mode-->3 μm in diameter--results from dispersion of mechanically generated particles, especially soil. The two modes overlap in such a way that they cannot be completely separated. Since the high volume sampler will readily accept "giant" particles which the dichotomous sampler rejects, and since the generation of large particles is essentially independent of the generation of small particles, the greater total mass measured by the high volume samplers may be due to the relative importance of the large particle mode in the aerosol size distribution around St. Louis. Known sources of dust in the area include rock quarries, bituminous coal fired boilers, cement manufacturing, and wind erosion of soil. Dzubay has applied a chemical element balance model to the dichotomous sampler data from St. Louis to resolve the aerosol sources into six components.[**] He found that the two crustal components account for 43% of the total mass.

Another design difference between the high volume and the dichotomous samplers is characteristic of the filters used to collect aerosol particles. The high volume instrument uses a glass fiber filter while the filter for the dichotomous sampler was a cellulose ester membrane. The glass fibers may act as a catalyst to cause the formation of SO_4 particles from SO_2 gas.[#] This may partially explain the additional sulfate in the high volume measurements. The higher correlations between the high volume and dichotomous measurements probably result from the fact that most of the sulfate (89%) is in the fine fraction.

---

[*] Ludgren, D. A., and H. J. Paulus, "The Mass Distribution of Large Atmospheric Particles." Journal of the Air Pollution Control Association, Vol. 25, No. 12 (December 1975). p. 227.

[**] Dzubay, Thomas G., "Chemical Element Balance Method Applied to Dichotomous Sampler Data." Annals of the New York Academy of Sciences, Vol. 338 (May 1980). p. 126-144.

[#] Proceedings of the Symposium for Discussion of the Los Angeles Catalyst Study, hosted by Environmental Protection Agency, Raleigh NC, April 1977. p.430.

Other differences between the two instruments include the lack of symmetry in the gable roof of the high volume sampler, which makes its collection efficiency sensitive to wind direction, and the mode of operation. The dichotomous samplers were operated continuously with automatic changing of filters at the end of each sampling interval. The high volume samplers were operated intermittently from midnight to midnight on a three or six day cycle; filters remained in the instrument for several hours after the air flow was shut off and some additional particles may have settled onto them.

The dichotomous sampler provides much more information about aerosol particles than does the high volume instrument. Not only does it discriminate between health-related fine particles and coarse particles, but it also resolves the 27 individual elements in each fraction. However, in order to track trends in air pollution, current data must be compared with historic data, most of which was produced by high volume samplers. At present it is not possible to use dichotomous sampler measurements to predict what a high volume instrument would have measured in the same place at the same time.

The analysis of the dichotomous sampler data by fractions showed that the total mass was approximately equally divided between the fine and the coarse fractions. There was no significant variation in the fine:total ratios among stations. Overall, the ratio was 0.518 ± .001 for mass; 0.885 ± .001 for sulfur; 0.799 ± .001 for lead.* The correlation between fine and coarse fractions was highest for bromine and titanium, lower for lead and sulfur, and even lower for total mass. The correlations among elements were highest for sulfur with total mass in the coarse fraction, for iron with total mass in the fine fraction, and for lead with bromine in both fractions. The high correlation between lead and bromine is expected, since both are primarily due to auto emissions.

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* This fine:total ratio for mass is significantly lower than the value of 0.61 reported by Trijonis et al. "Analysis of the St. Louis RAMS Ambient Particulate Data," EPA-450/4-80-006a, February 1980.

REFERENCES

1. Stevens, R. K., and T. G. Dzubay. Dichotomous Sampler--A Practical Approach to Aerosol Fractionation and Collection. EPA-600/2-78-112, June 1978.

2. Goulding, F. S., et al. Aerosol Analysis for the Regional Air Pollution Study. EPA-600/4-78-034, July 1978.

3. Nelson, E. Regional Air Pollution Study--High Volume Filter Measurements of Suspended Particulate Matter. EPA-600/4-79-003, January 1979.

4. Screening Procedures for Ambient Air Quality Data. OAQPS, EPA-450/2-78-037, July 1978.

5. Stevens, R. K., et al. Sampling and Analysis of Atmospheric Sulfates and Related Species. In: Atmospheric Environment, Vol. 12. Permagon Press, 1978.

6. Nie, H. H., et al. Statistical Package for the Social Sciences, Second Edition. McGraw-Hill, 1975.

7. Camp, D. C., et al. Intercomparison of Samplers Used in Determination of Aerosol Composition. EPA-600/7-78-118, July 1978.

8. Lundgren, D. A., and H. J. Paulus. The Mass Distribution of Large Atmospheric Particles. In: Journal of the Air Pollution Control Association, Vol. 25, No. 12, December 1975. p. 1227.

9. Dzubay, T. G. Chemical Element Balance Method Applied to Dichotomous Sampler Data. Annals of the New York Academy of Sciences, Vol. 338 (May 1980). p. 126-144.

10. Proceedings of the Symposium for Discussion of the Los Angeles Catalyst Study. Hosted by Environmental Protection Agency in Raleigh, N.C., April 1977. p. 430.

11. Trijonis, J., et al. Analysis of the St. Louis RAMS Ambient Particulate Data. EPA-450/4-80-006a, February 1980.

APPENDIX A

REVIEW OF STATISTICS USED IN ANALYSIS

MEAN AND CORRELATION

Statistical Definitions

Mean determined as -- $\overline{X} = \frac{\sum_{i=1}^{N} X_i}{N}$

Std. error in mean -- std. error = std deviation in distribution of sample means

$$S^2 = \frac{\sum_{i=1}^{N} (X_i - \overline{X})^2}{N-1} \qquad SD = \sqrt{S^2} = S$$

$$\text{std. err.} = \sqrt{S^2/N}$$

Correlation coefficients (Pearson)

$$r = \frac{\sum_{i=1}^{N} (X_i - \overline{X})\ (Y - \overline{Y})}{\left\{\left[\sum_{i=1}^{N} (X_i - \overline{X})^2\right]\left[\sum_{i=1}^{N} (Y_i - \overline{Y})^2\right]\right\}^{1/2}}$$

$$= \frac{\sum_{i=1}^{N} X_i Y_i - \left(\sum_{i=1}^{N} X_i\right)\left(\sum_{i=1}^{N} Y_i\right)/N}{\left\{\left[\sum_{i=1}^{N} X_i^2 - \left(\sum_{i=1}^{N} X_i\right)^2/N\right]\left[\sum_{i=1}^{N} Y_i^2 - \left(\sum_{i=1}^{N} Y_i\right)^2/N\right]\right\}^{1/2}}$$

Significance → use Student's t test (one-tailed) with (N-2) degrees of freedom

$$r \left[\frac{N-2}{1-r^2}\right]^{1/2}$$

REGRESSION

Regression Coefficient

$$B = \frac{\Sigma\ (X-\bar{X})\ (Y-\bar{Y})}{\Sigma\ (X-\bar{X})^2}$$

$$A = \bar{Y} - B\bar{X}$$

Pearson Corr. Coeff.

$$r^2_{xy} = \frac{\Sigma\ (Y' - \bar{Y})^2}{\Sigma\ (Y - \bar{Y})^2} \qquad \text{where } Y' = A + BX$$

Standard Error of Estimate

$$SEE = \sqrt{\frac{\Sigma\ (Y - Y')^2}{N-2}}$$

95% Confidence interval of A

Using A and B, we predict Y_o for a particular X_o. This prediction will differ from the one we would make if A and B were not based on a sample. The difference is related to Students' t statistic as follows:

$$t = \frac{Y_o - Y' \sqrt{N - 2}}{\sqrt{\frac{\Sigma\ (Y - Y')^2}{N}}\ \sqrt{N + 1\ \frac{N\ (X_o - \bar{X})^2}{\Sigma\ (X - \bar{X})^2}}}$$

$$\text{For } X_o = 0, Y_o - Y' = t\ (SEE) \sqrt{\frac{1}{N} + 1 + \frac{X^2}{\Sigma\ (X - \bar{X})^2}}$$

Standard Error of B

$$\sqrt{Var\ B} = \sqrt{\frac{\Sigma\ (Y - Y')^2/(N-2)}{\Sigma\ (X - \bar{X})^2}}$$

95% Confidence interval of B

The confidence interval is related to Student's t statistic as follows: B ± (Student's t) (std. err. of B).

APPENDIX B

FLOWCHARTS OF COMPUTER PROGRAMS

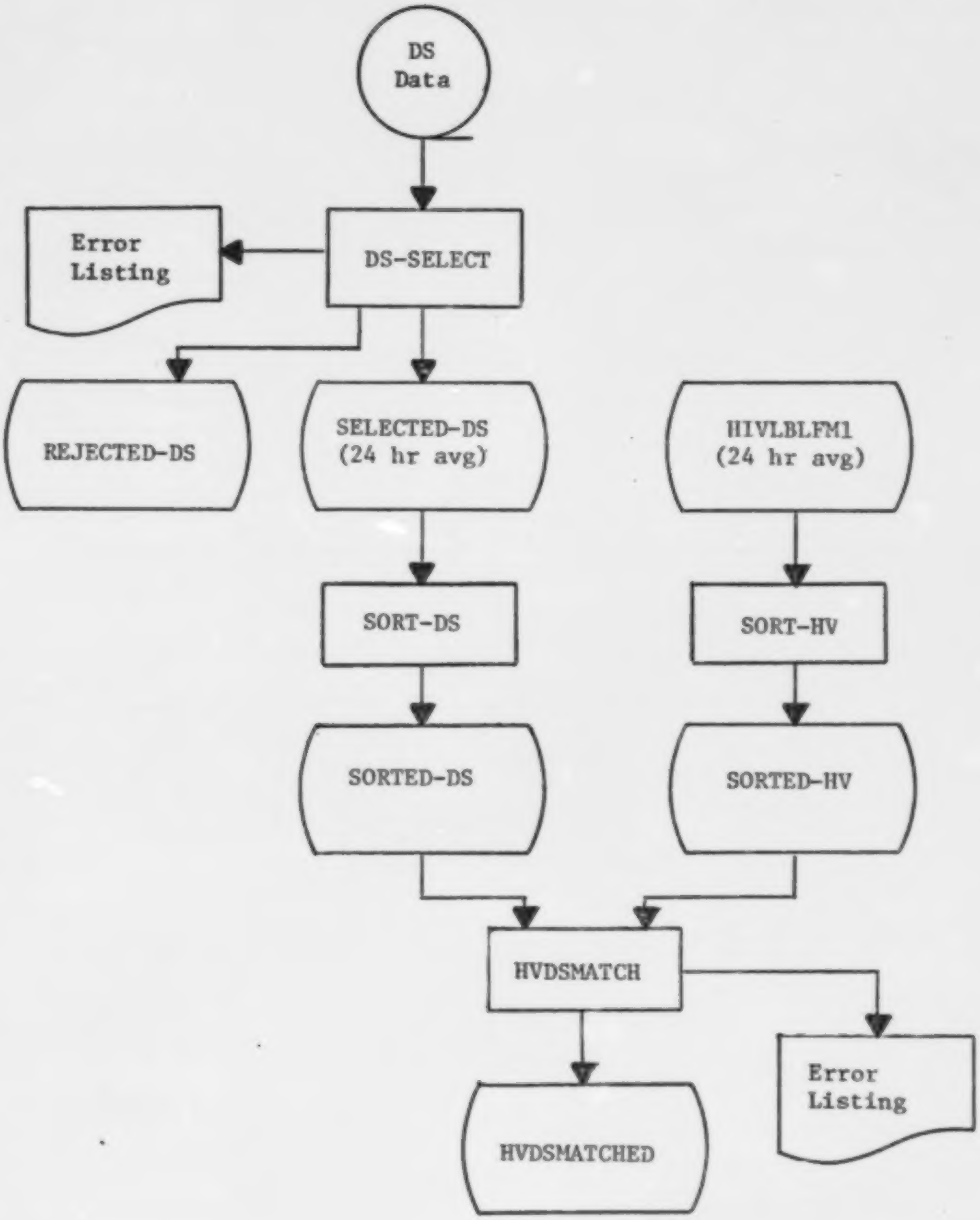

DS Data
DS-SELECT
Error Listing
REJECTED-DS
SELECTED-DS (24 hr avg)
HIVLBLFM1 (24 hr avg)
SORT-DS
SORT-HV
SORTED-DS
SORTED-HV
HVDSMATCH
HVDSMATCHED
Error Listing

Figure B.1 System flowchart, data processing and analyses.

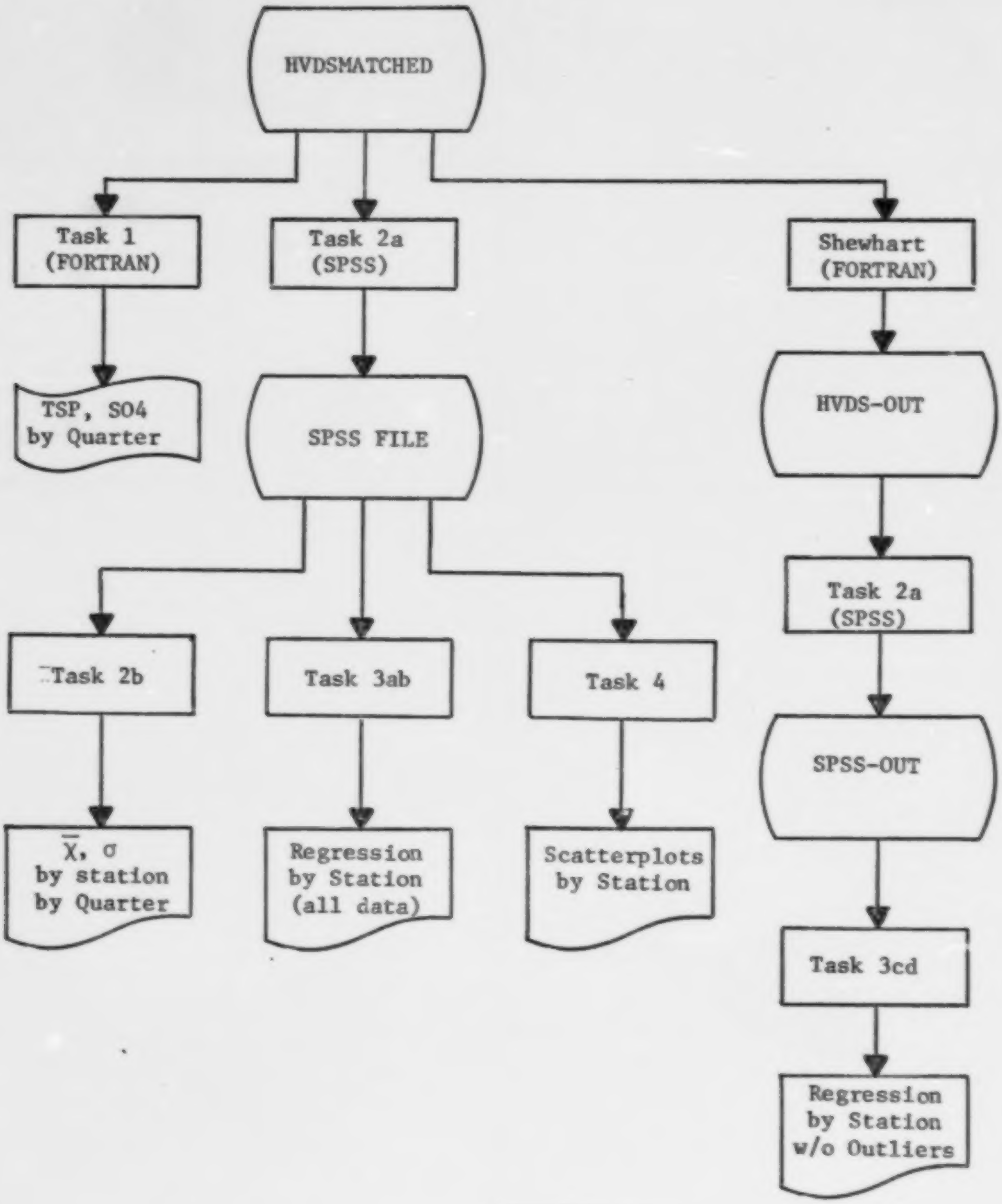
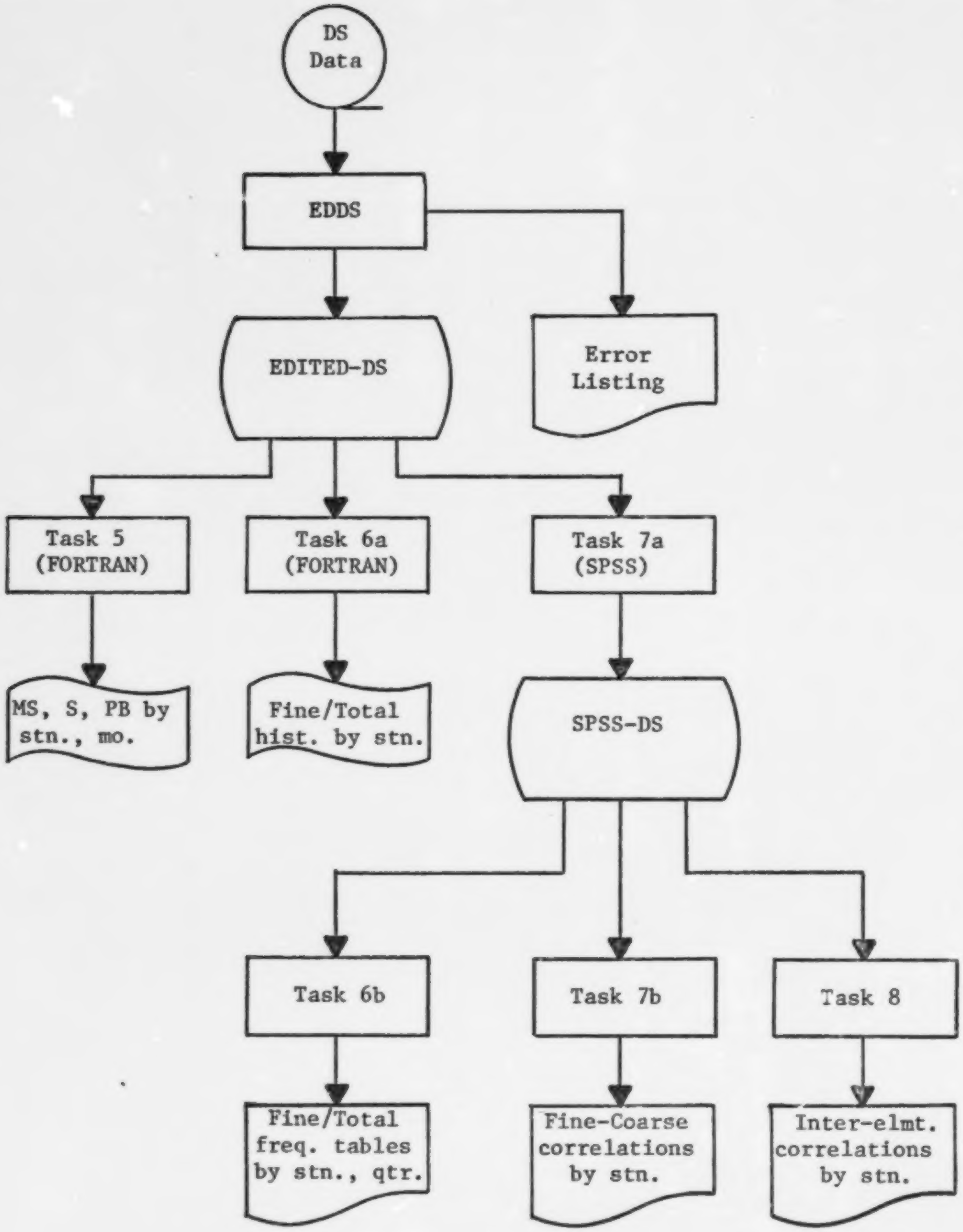

HVDSMATCHED
Task 1 (FORTRAN)
Task 2a (SPSS)
Shewhart (FORTRAN)
TSP, SO4 by Quarter
SPSS FILE
HVDS-OUT
Task 2a (SPSS)
Task 2b
Task 3ab
Task 4
SPSS-OUT
$\overline{X}$, σ by station by Quarter
Regression by Station (all data)
Scatterplots by Station
Task 3cd
Regression by Station w/o Outliers

Figure B.1 System flowchart, data processing and analyses (continued).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EDDS
EDITED-DS
Error Listing
Task 5 (FORTRAN)
Task 6a (FORTRAN)
Task 7a (SPSS)
MS, S, PB by stn., mo.
Fine/Total hist. by stn.
SPSS-DS
Task 6b
Task 7b
Task 8
Fine/Total freq. tables by stn., qtr.
Fine-Coarse correlations by stn.
Inter-elmt. correlations by stn.

Figure B.1 System flowchart, data processing and analyses (continued).

APPENDIX C

TIME SERIES PLOTS OF HIGH VOLUME MEASUREMENTS VS. DICHOTOMOUS SAMPLER 24 HR AVERAGES FOR TOTAL MASS AND SULFATE BY STATION BY QUARTER

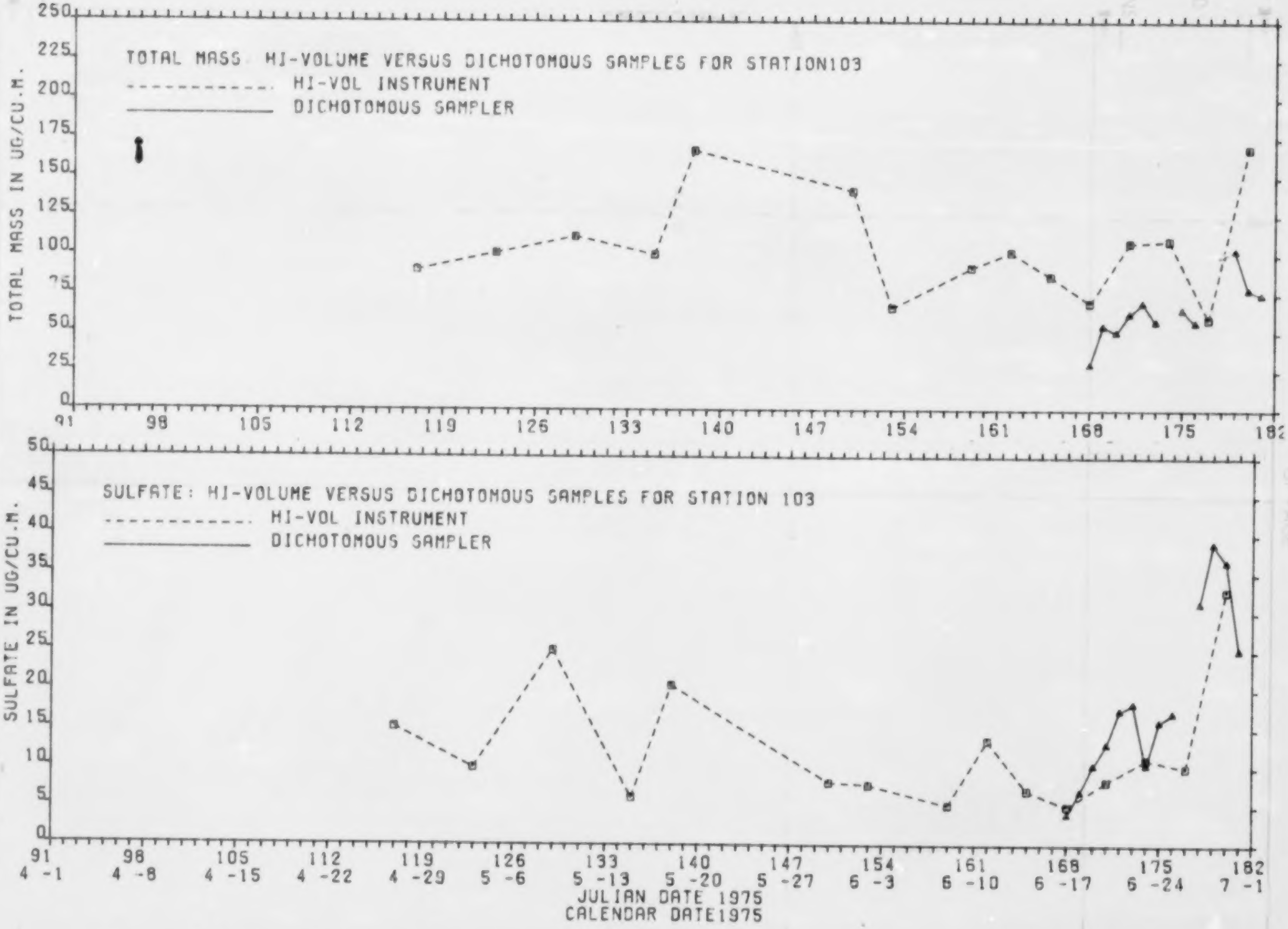

Figure C.1 Comparison of high volume versus dichotomous samples at station 103.

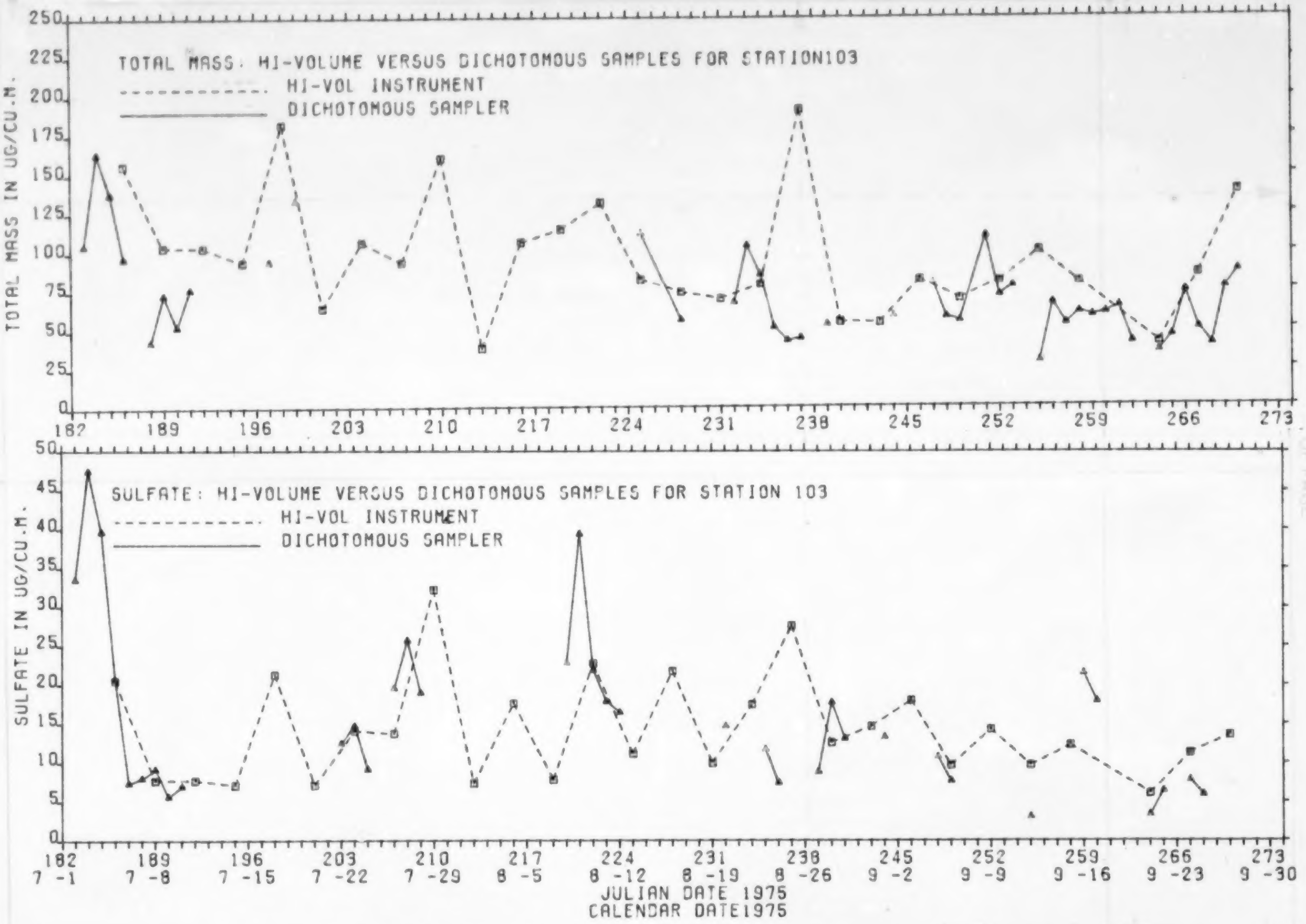

Figure C.2 Comparison of high volume versus dichotomous samples at station 103.

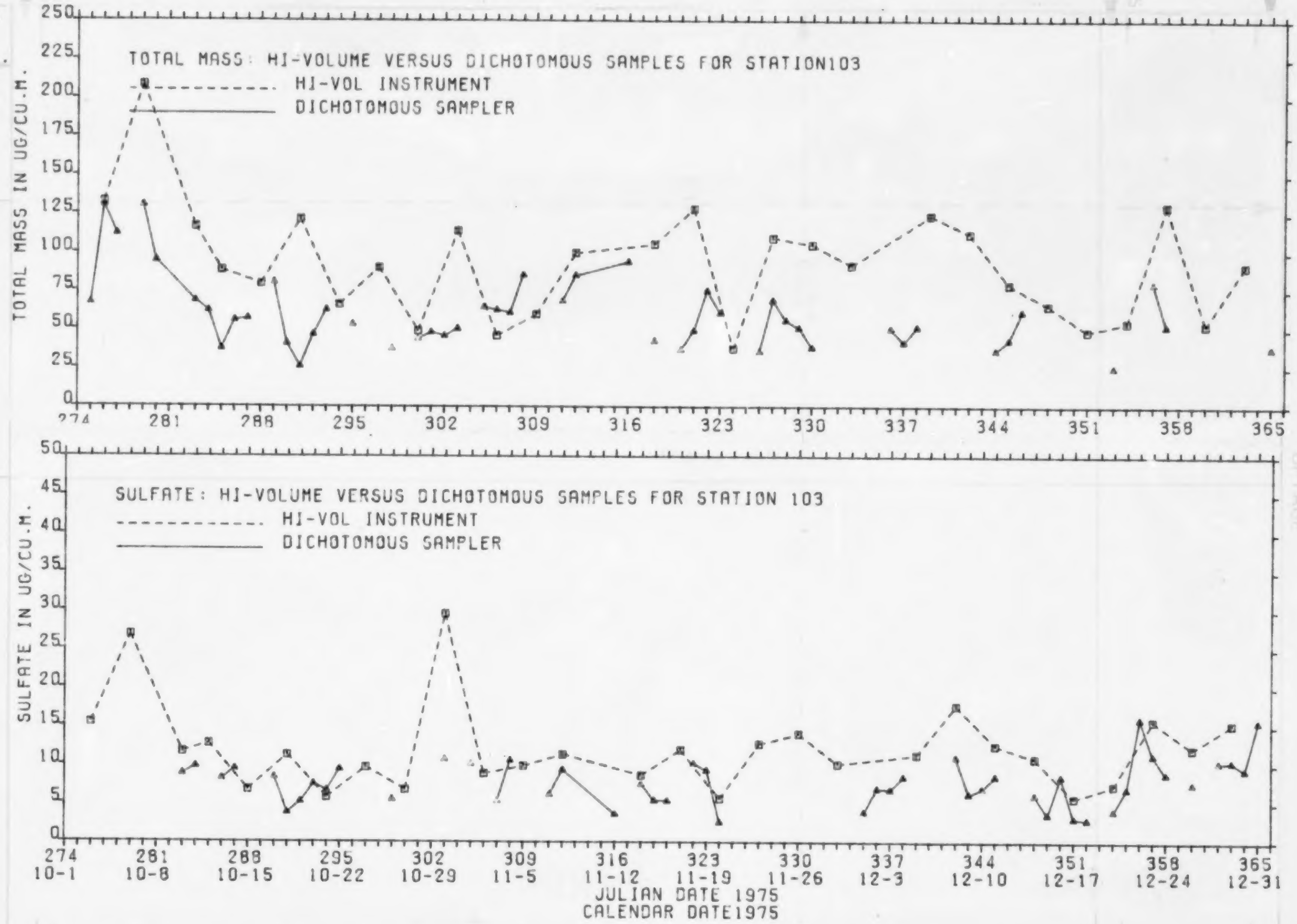

Figure C.3 **Comparison of high volume versus dichotomous samples at station** 103.

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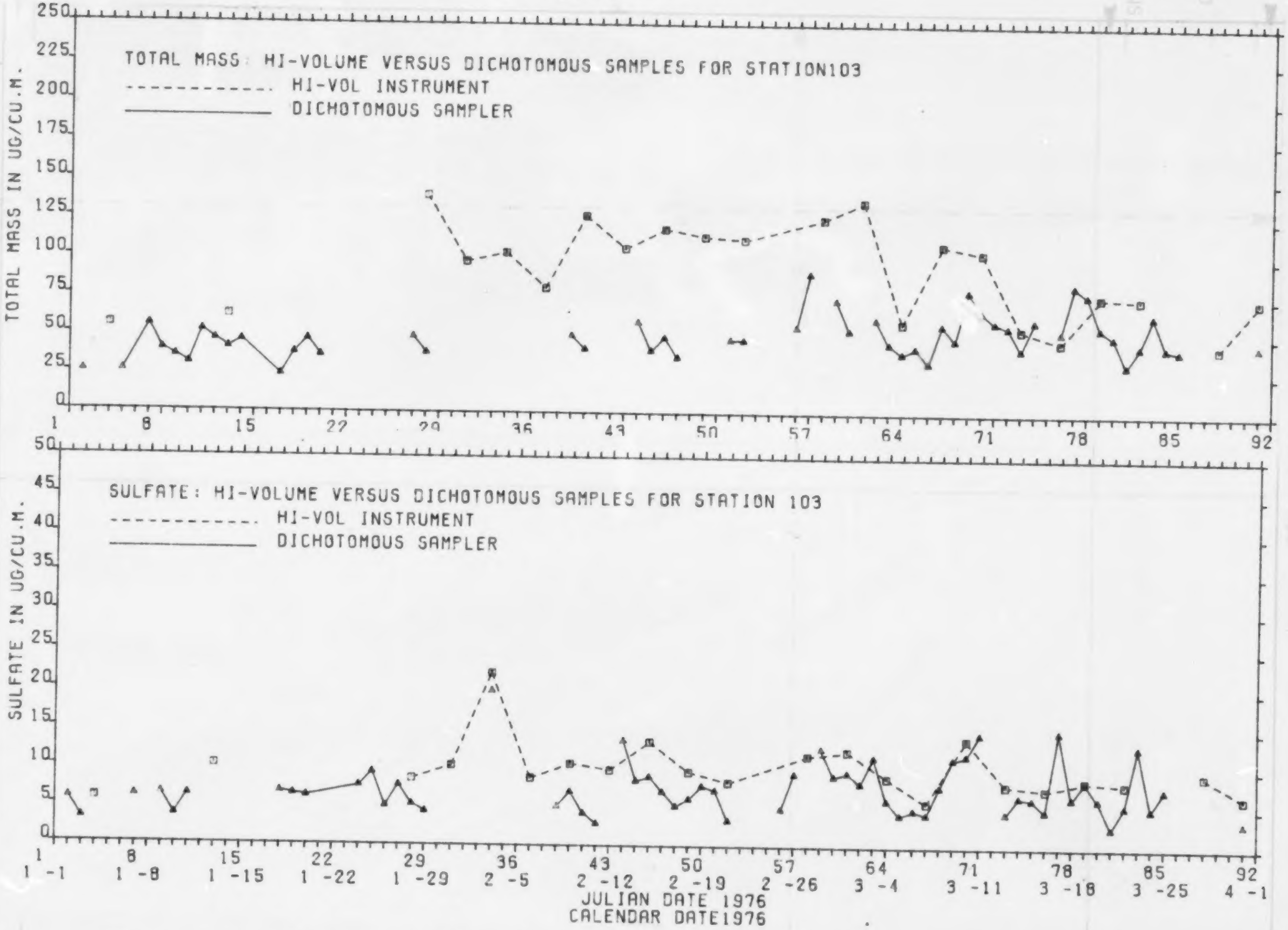

Figure C.4 **Comparison of high volume versus dichotomous samples at station** 103.

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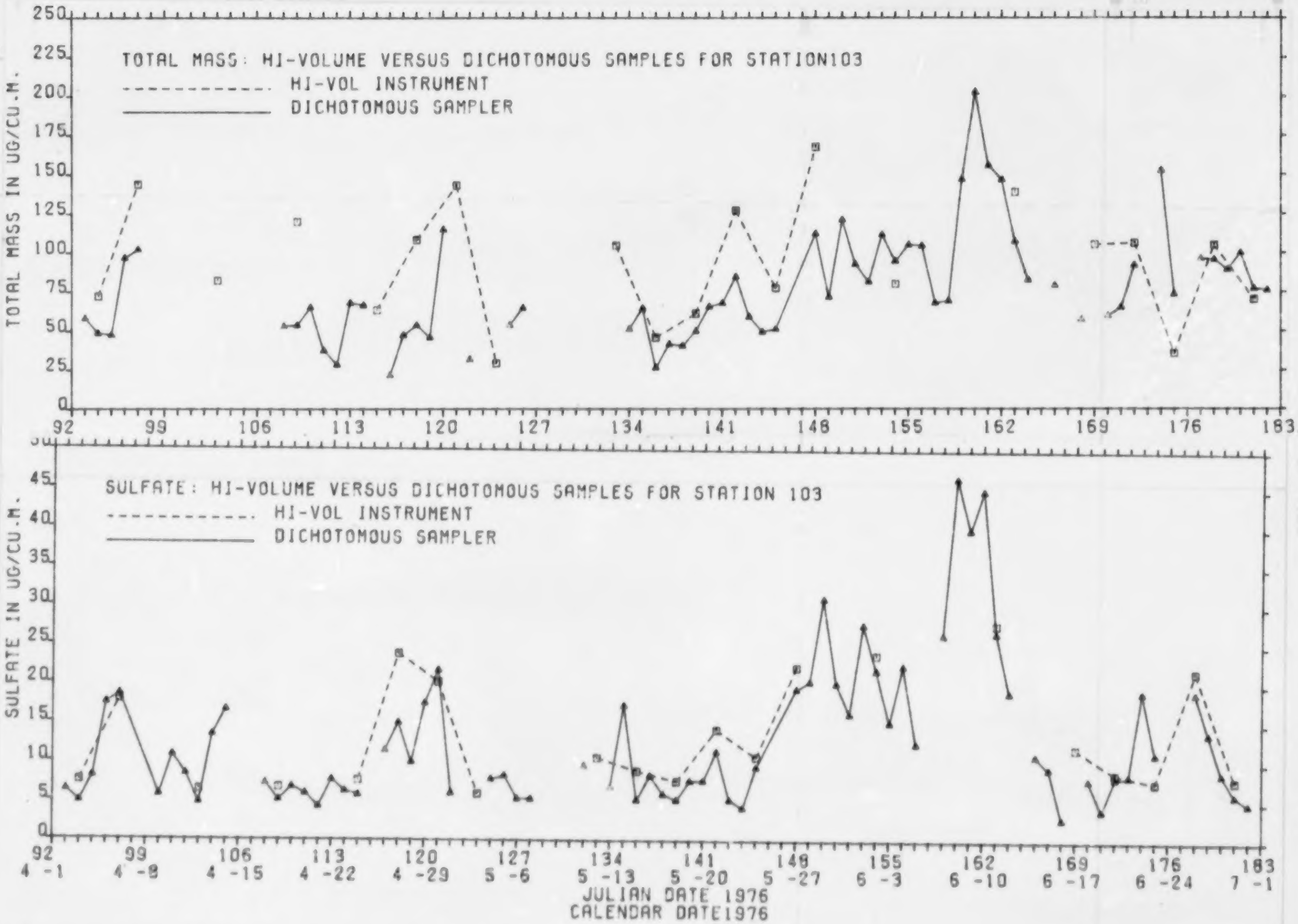

Figure C.5 **Comparison of high volume versus dichotomous samples at station** 103.

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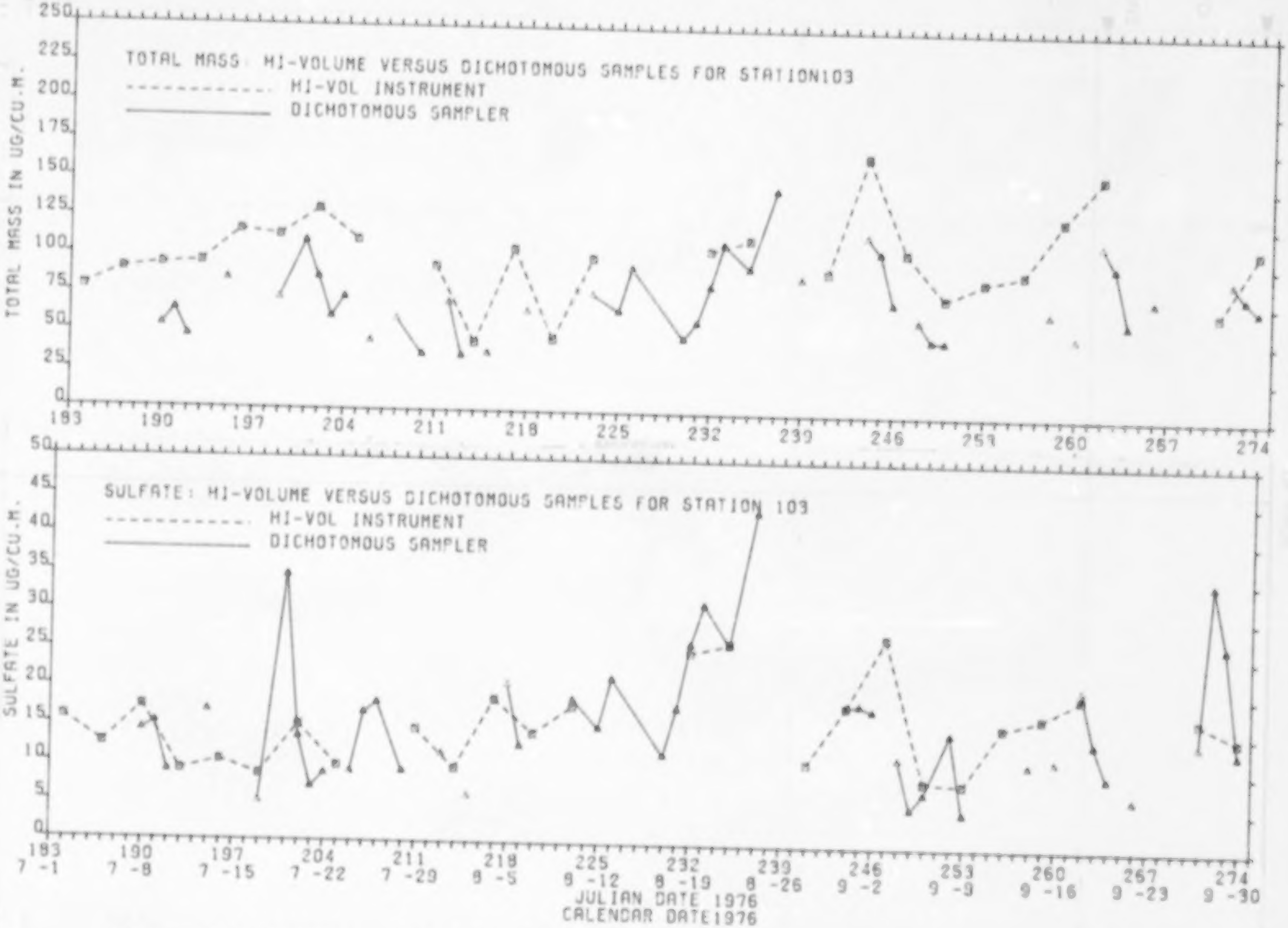


Figure C.6 **Comparison of high volume versus dichotomous samples at station** 103.

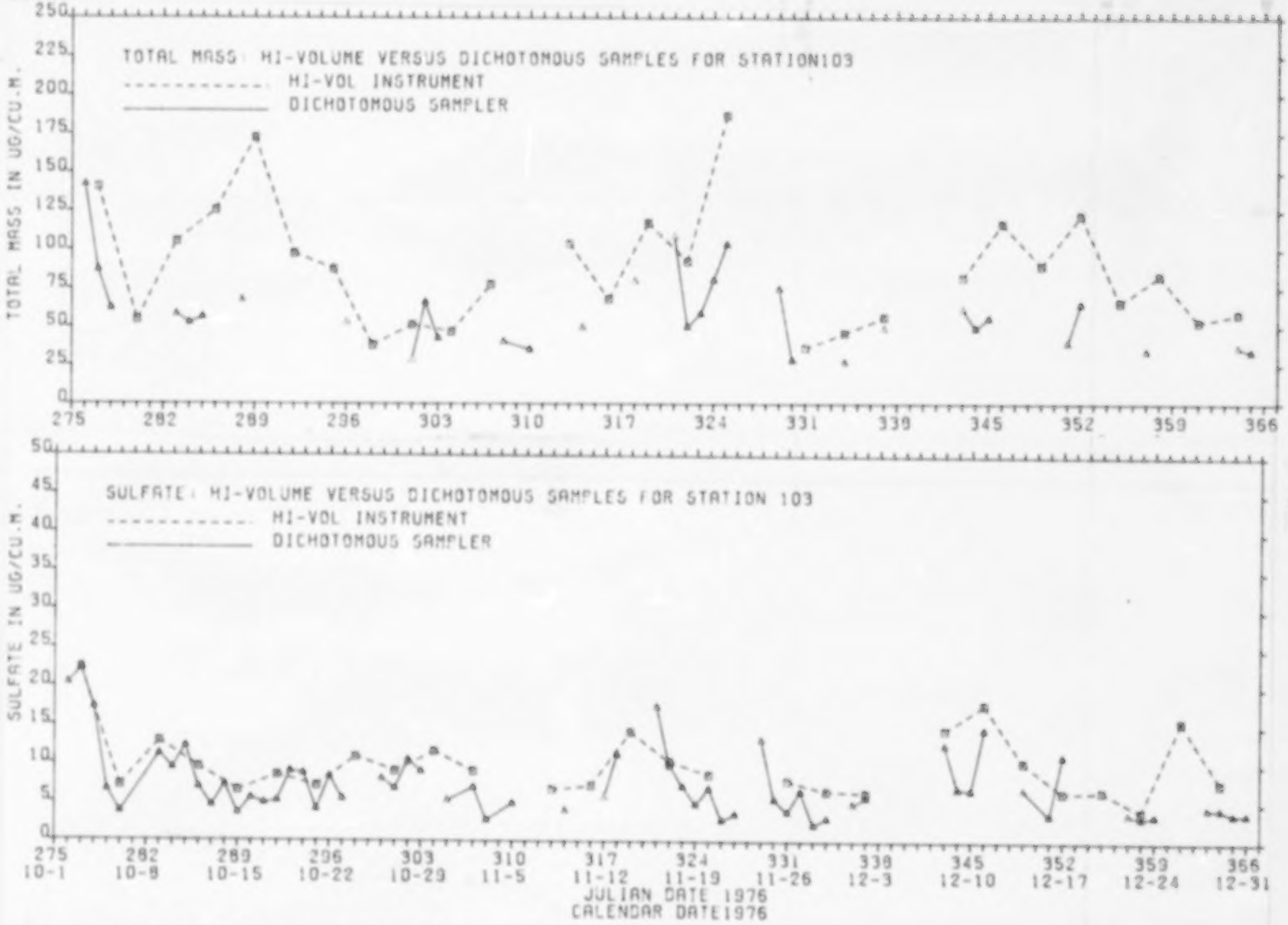


Figure C.7 **Comparison of high volume versus dichotomous samples at station** 103.

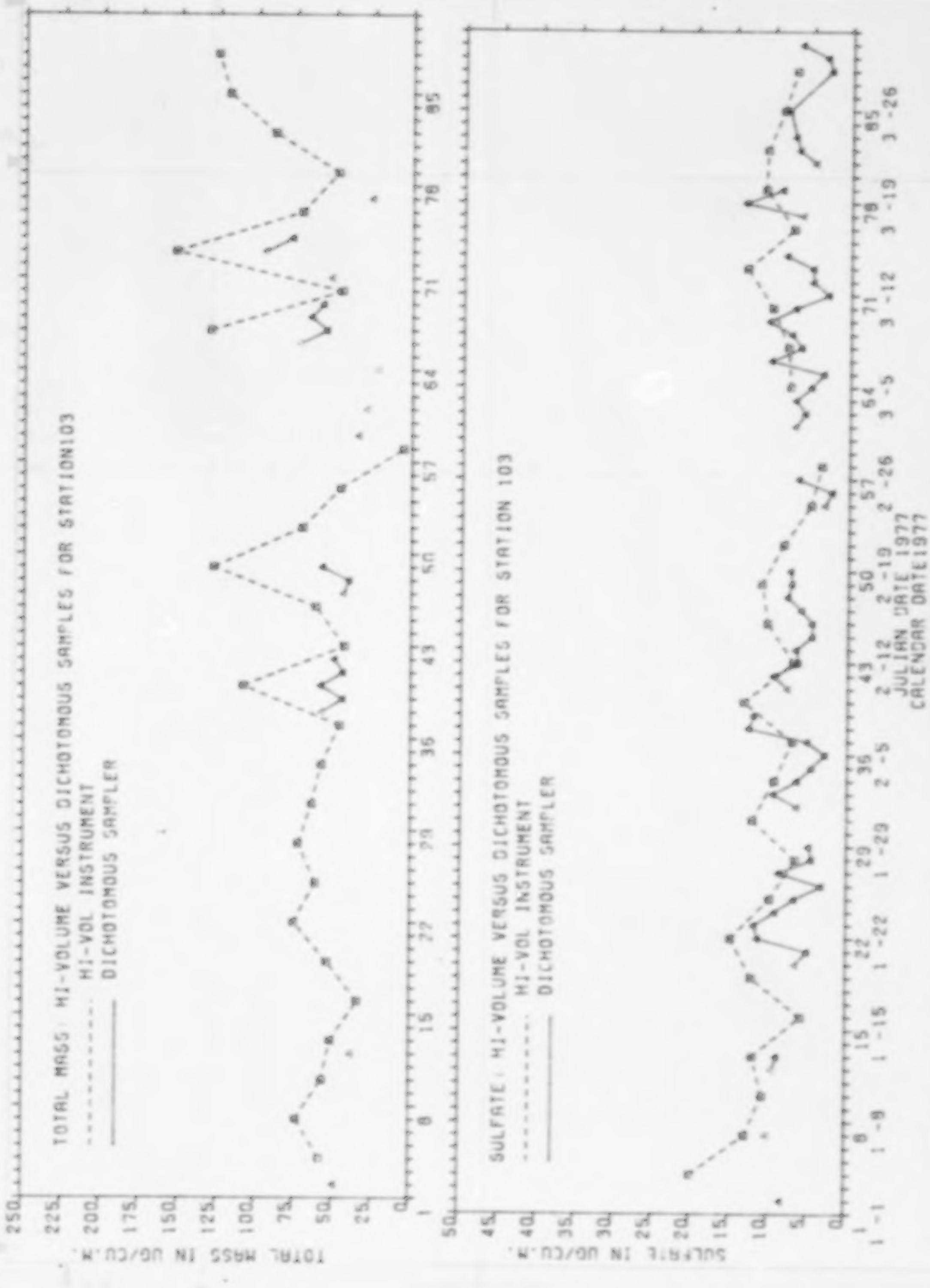


Figure C.8 Comparison of high volume versus dichotomous samples at station 103.

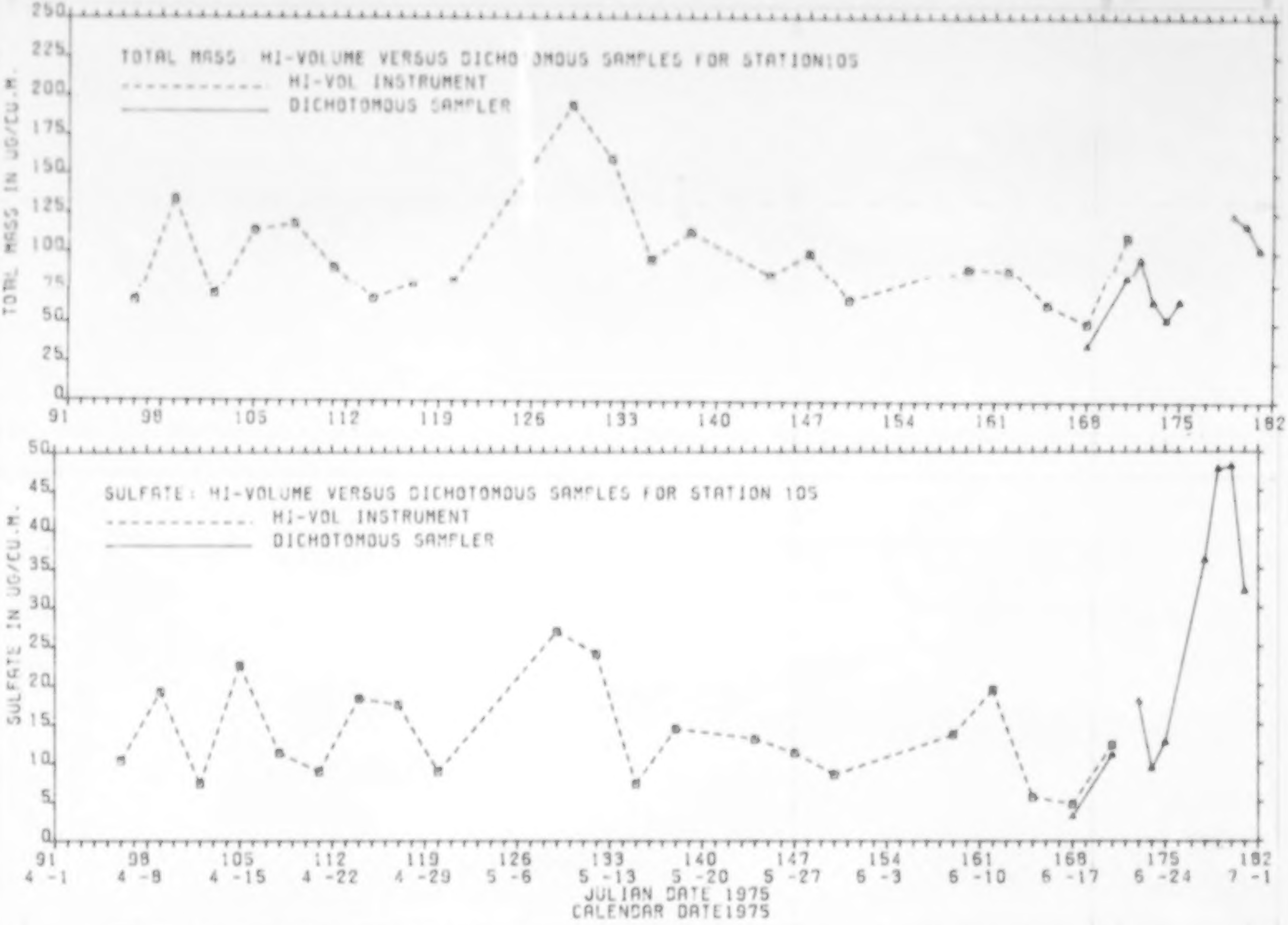


Figure C.9 **Comparison of high volume versus dichotomous samples at station** 105.

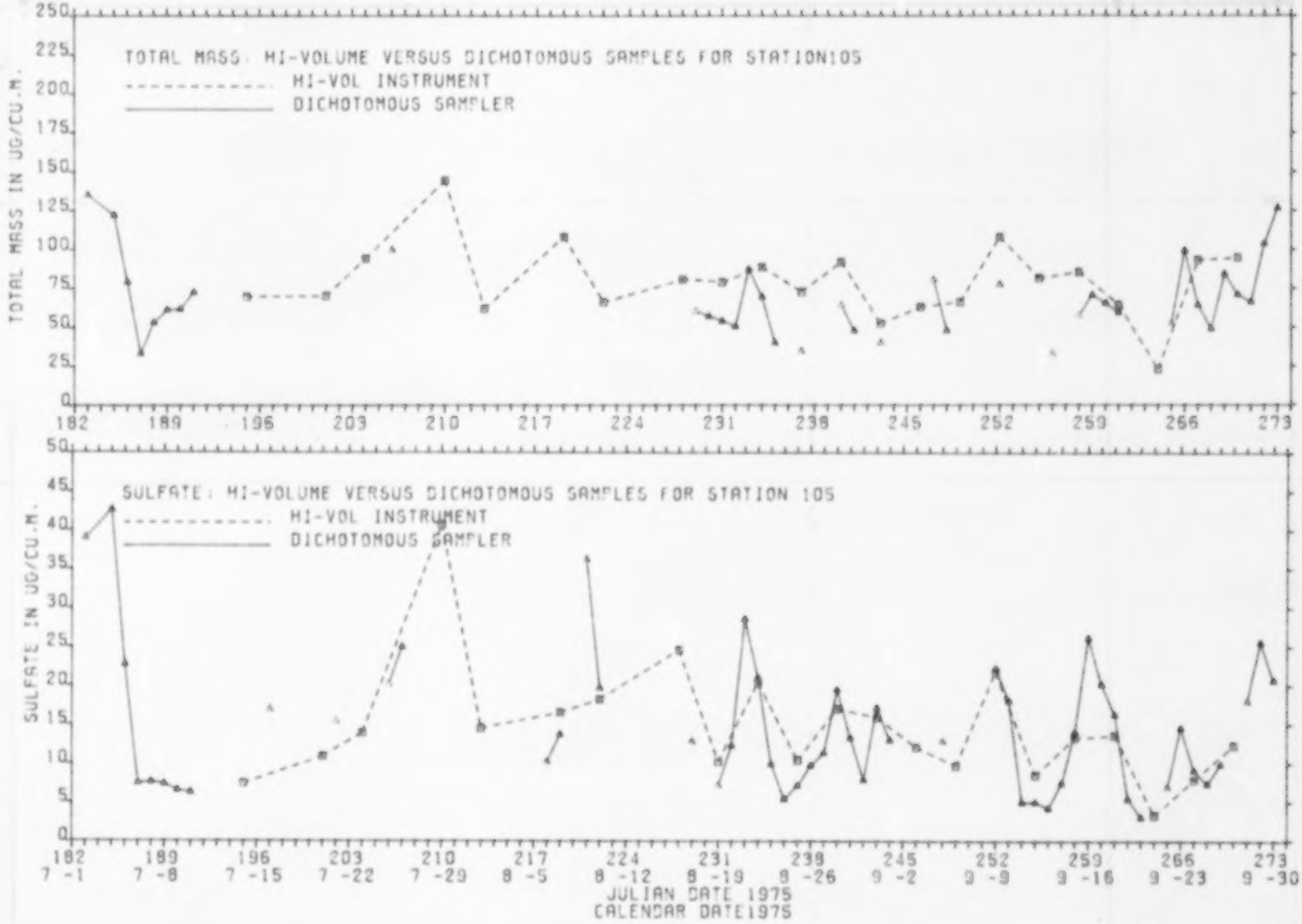


Figure C.10 **Comparison of high volume versus dichotomous samples at station** 105.

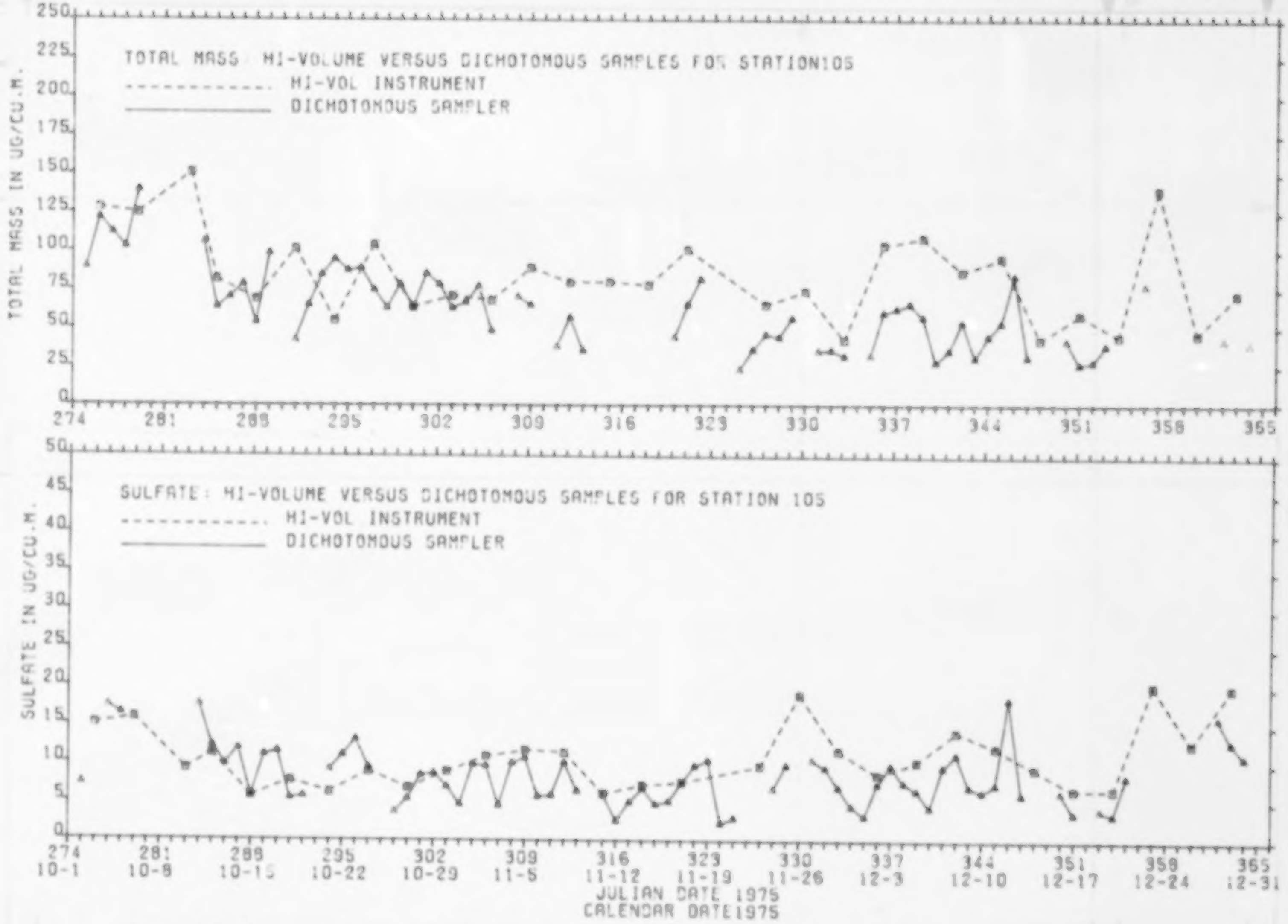


Figure C.11 -Comparison of high volume versus dichotomous samples at station 105.

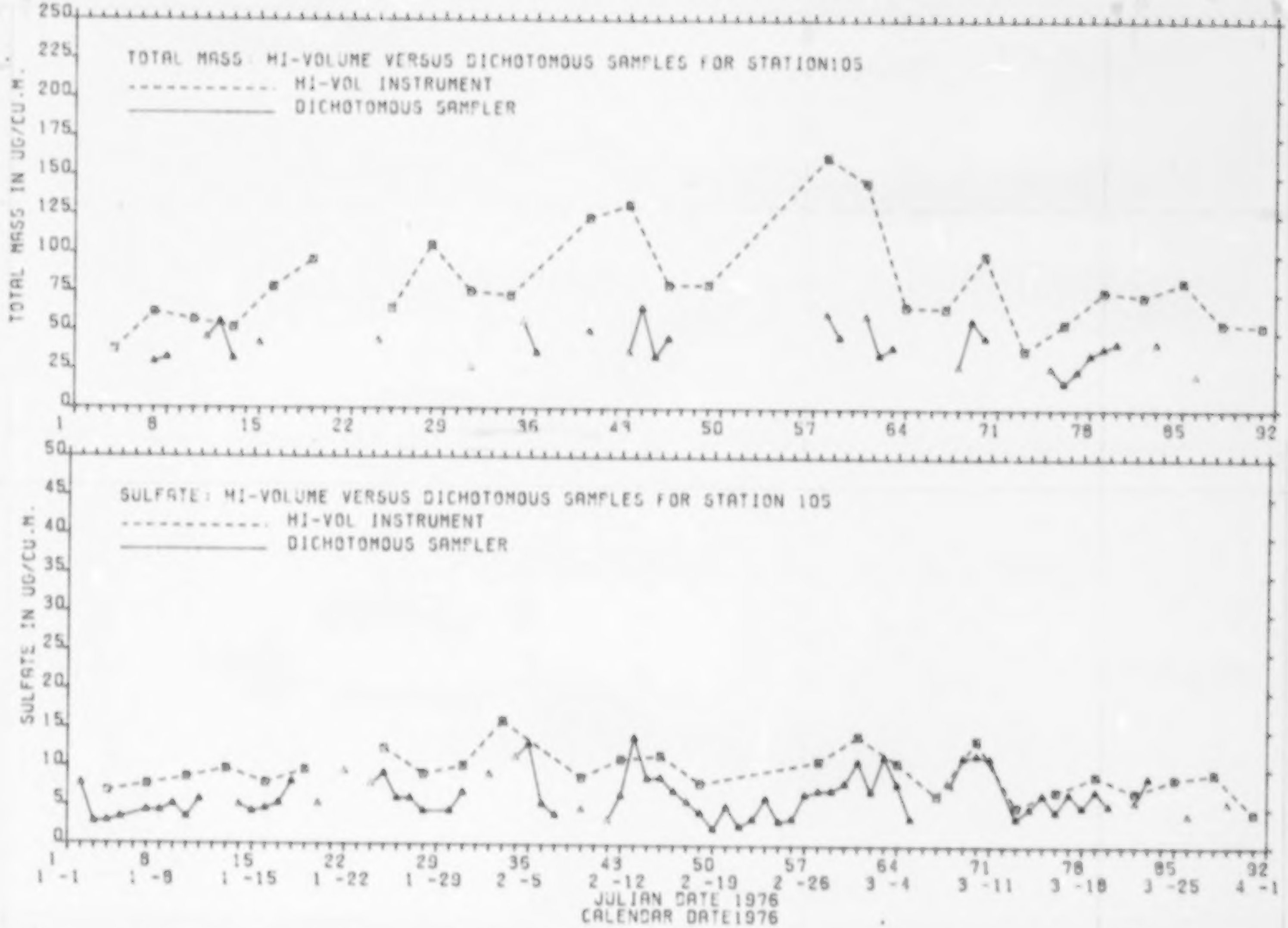


Figure C.12 **Comparison of high volume versus dichotomous samples at station** 105.

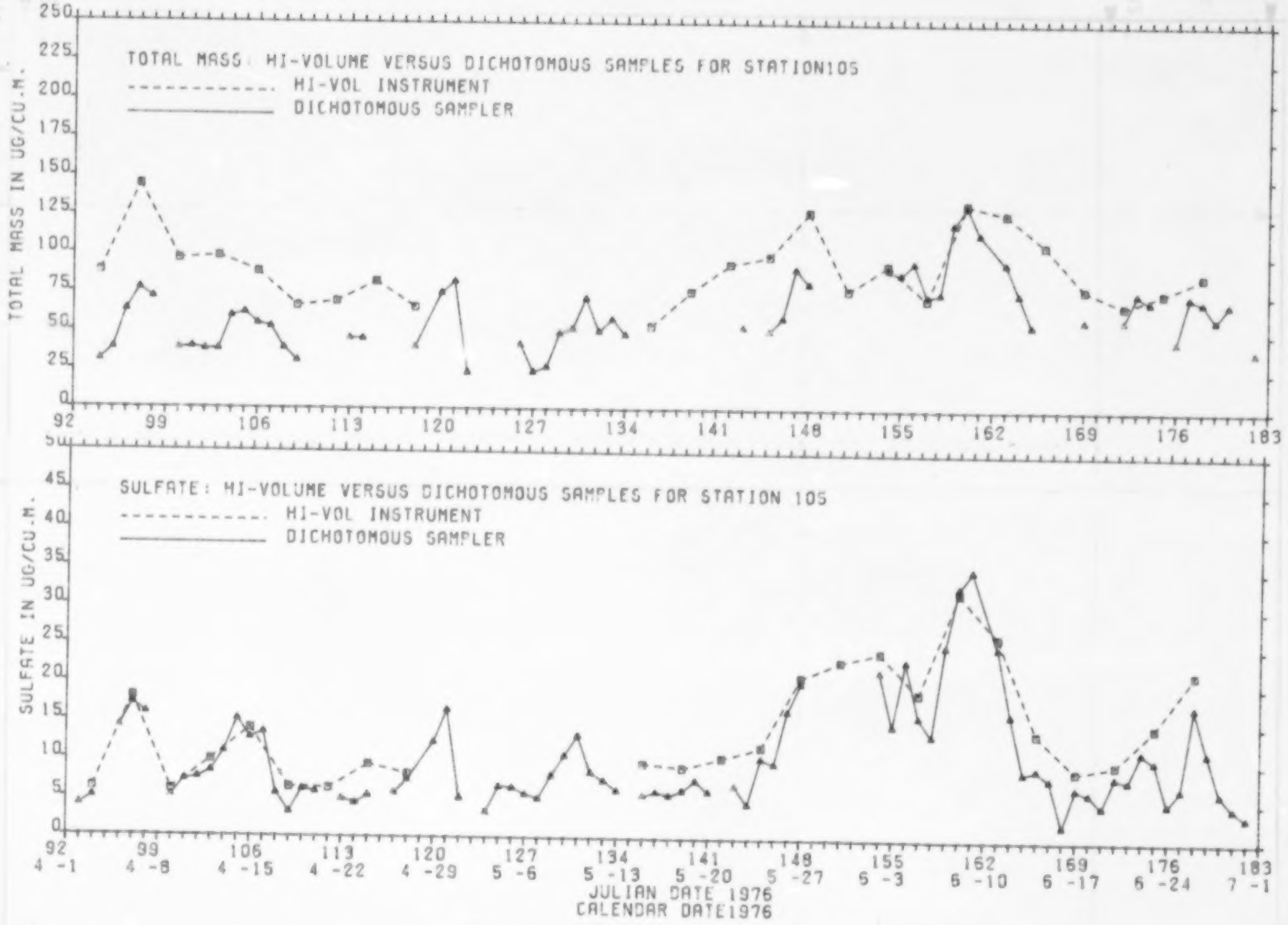


Figure C.13 **Comparison of high volume versus dichotomous samples at station** 105.

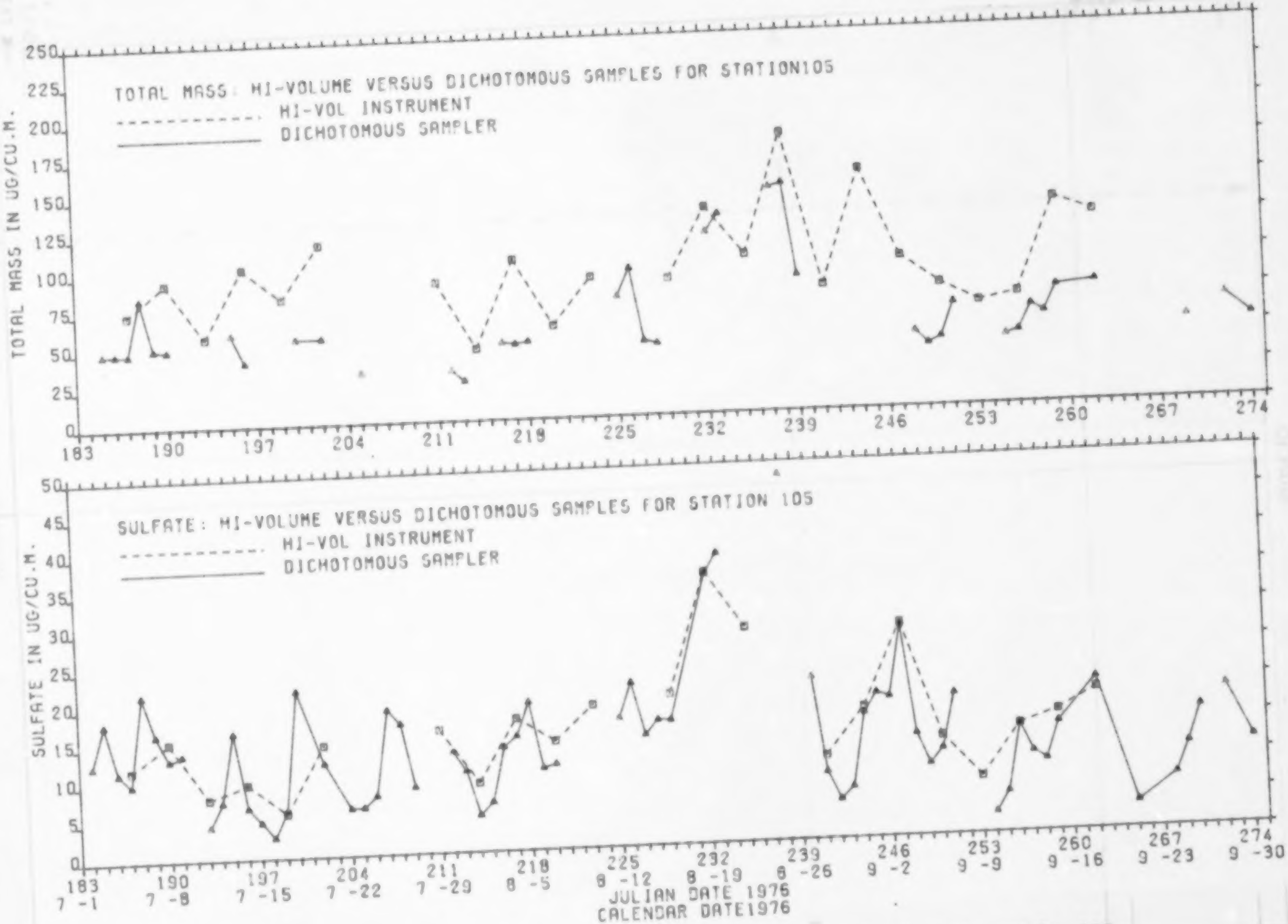


Figure C.14 **Comparison of high volume versus dichotomous samples at station** 105.

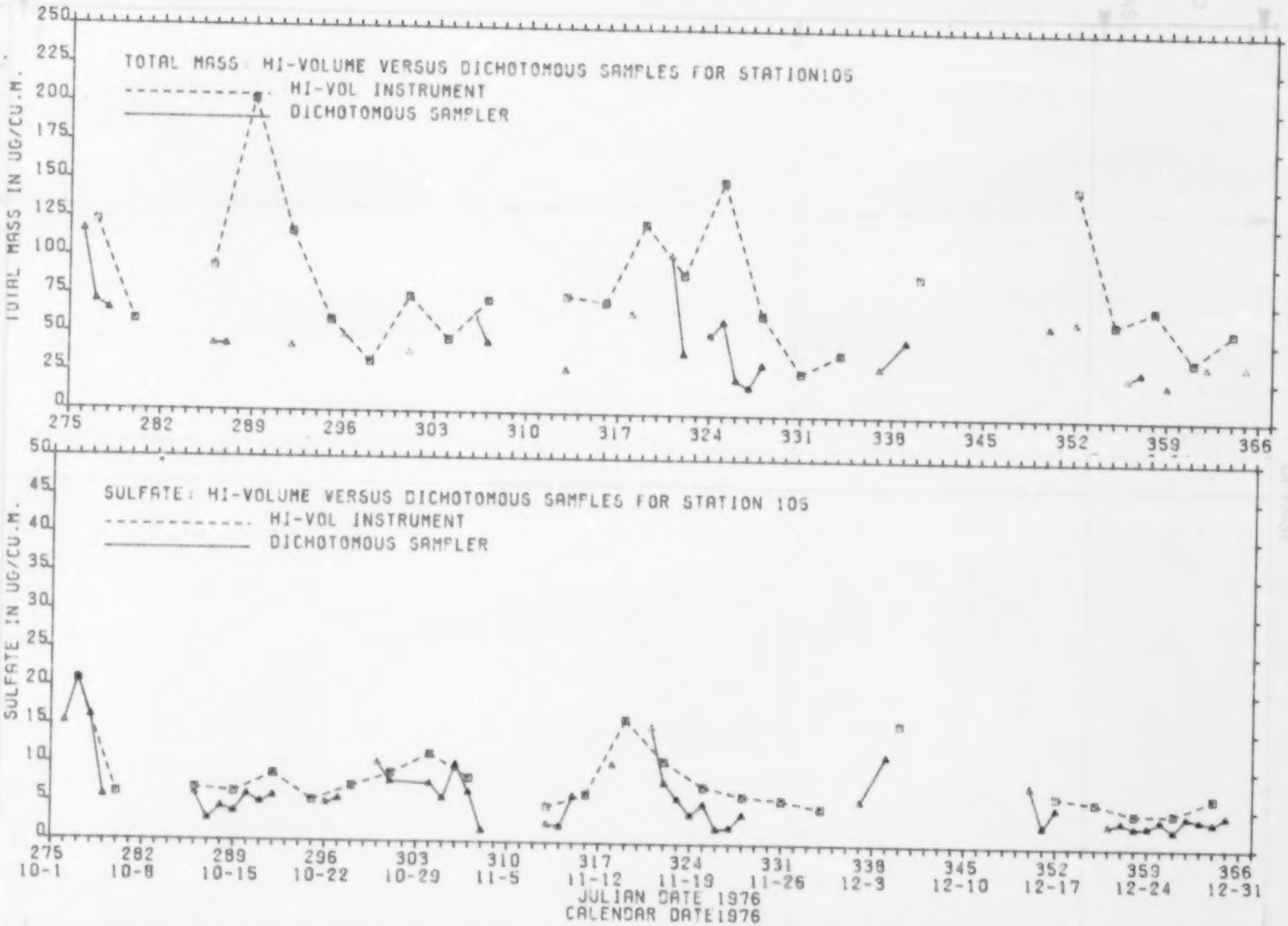


Figure C.15 **Comparison of high volume versus dichotomous samples at station** 105.

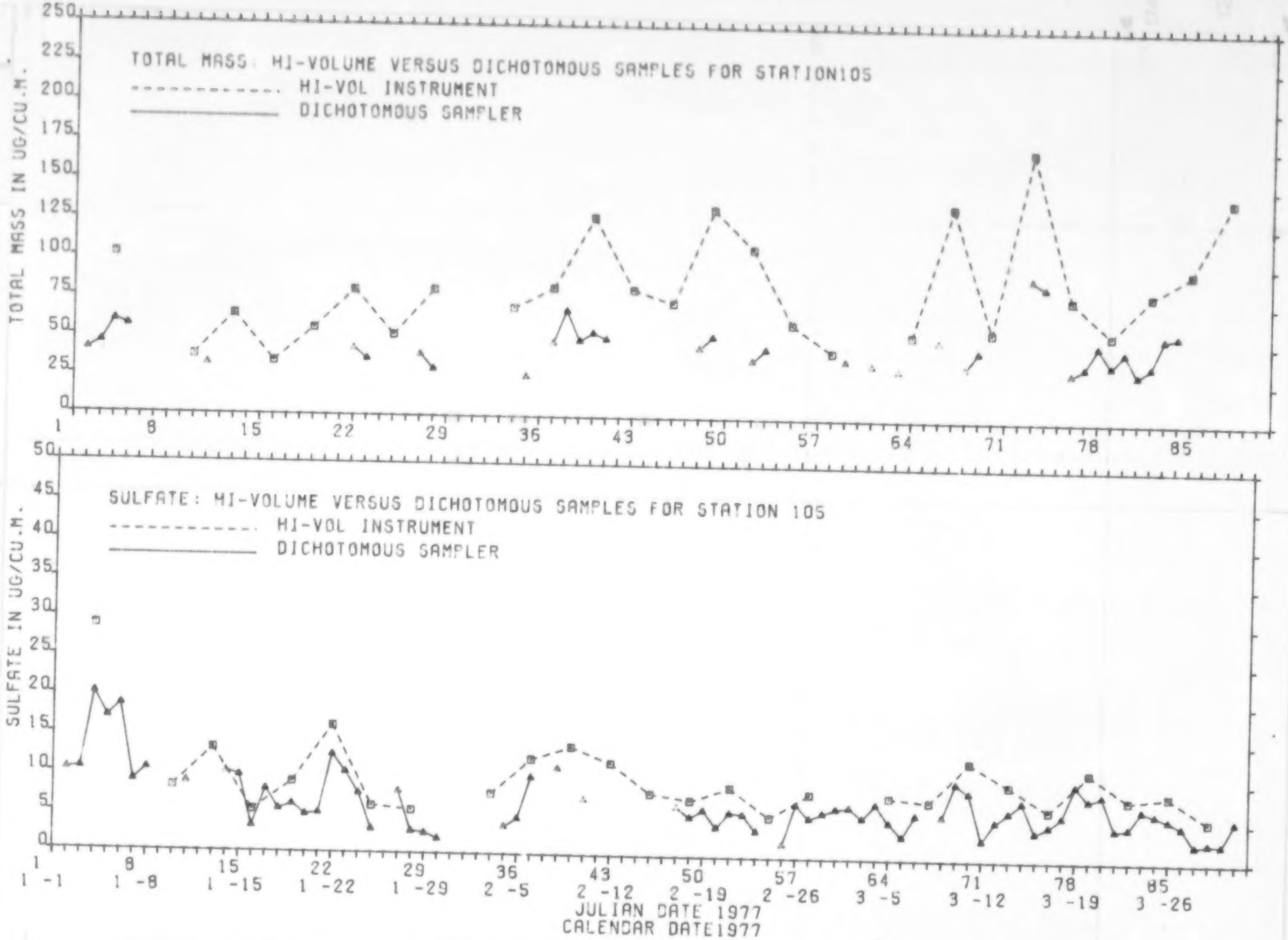


Figure C.16 Comparison of high volume versus dichotomous samples at station 105.

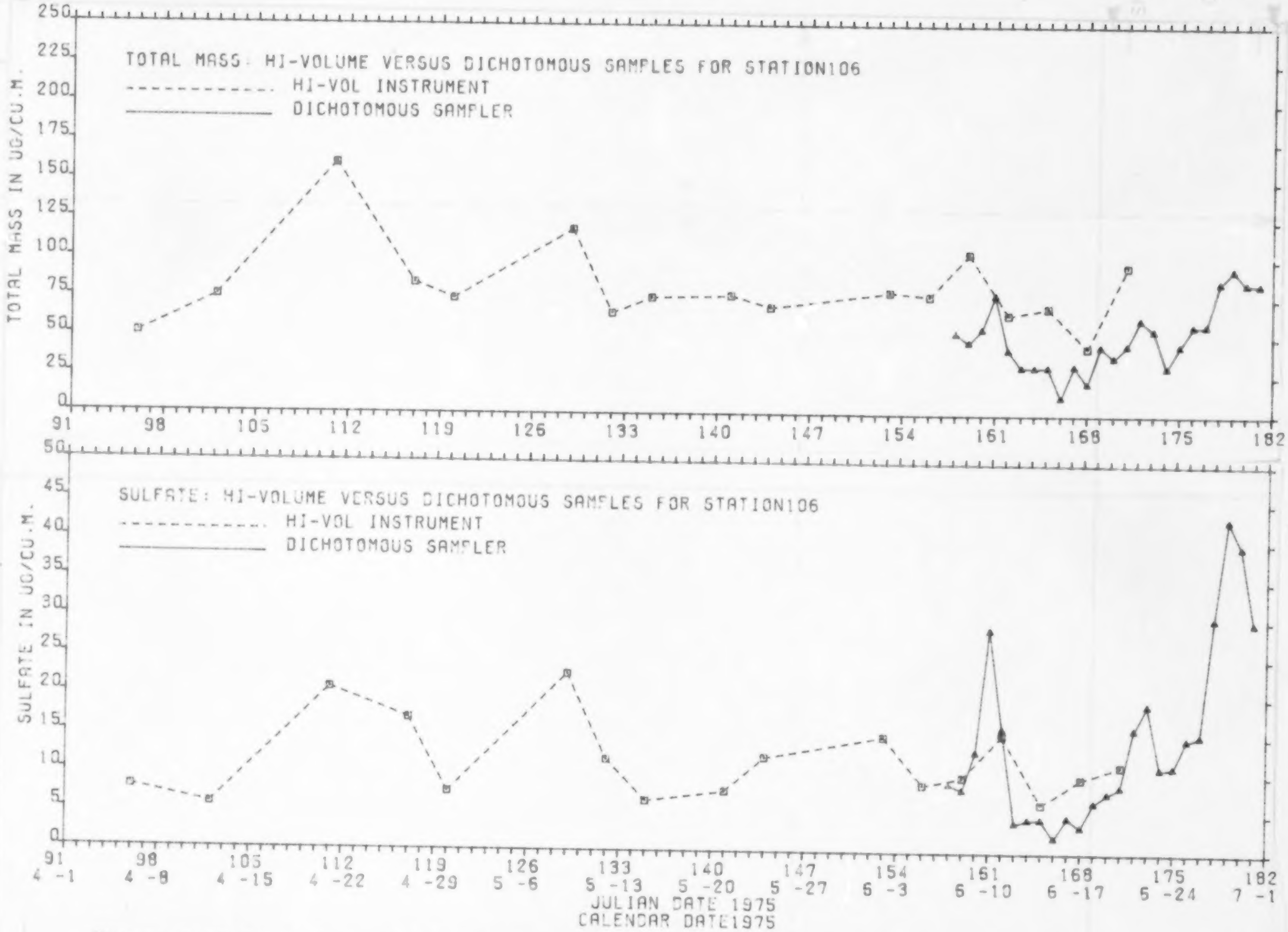


Figure C.17 Comparison of high volume versus dichotomous samples at station 106.

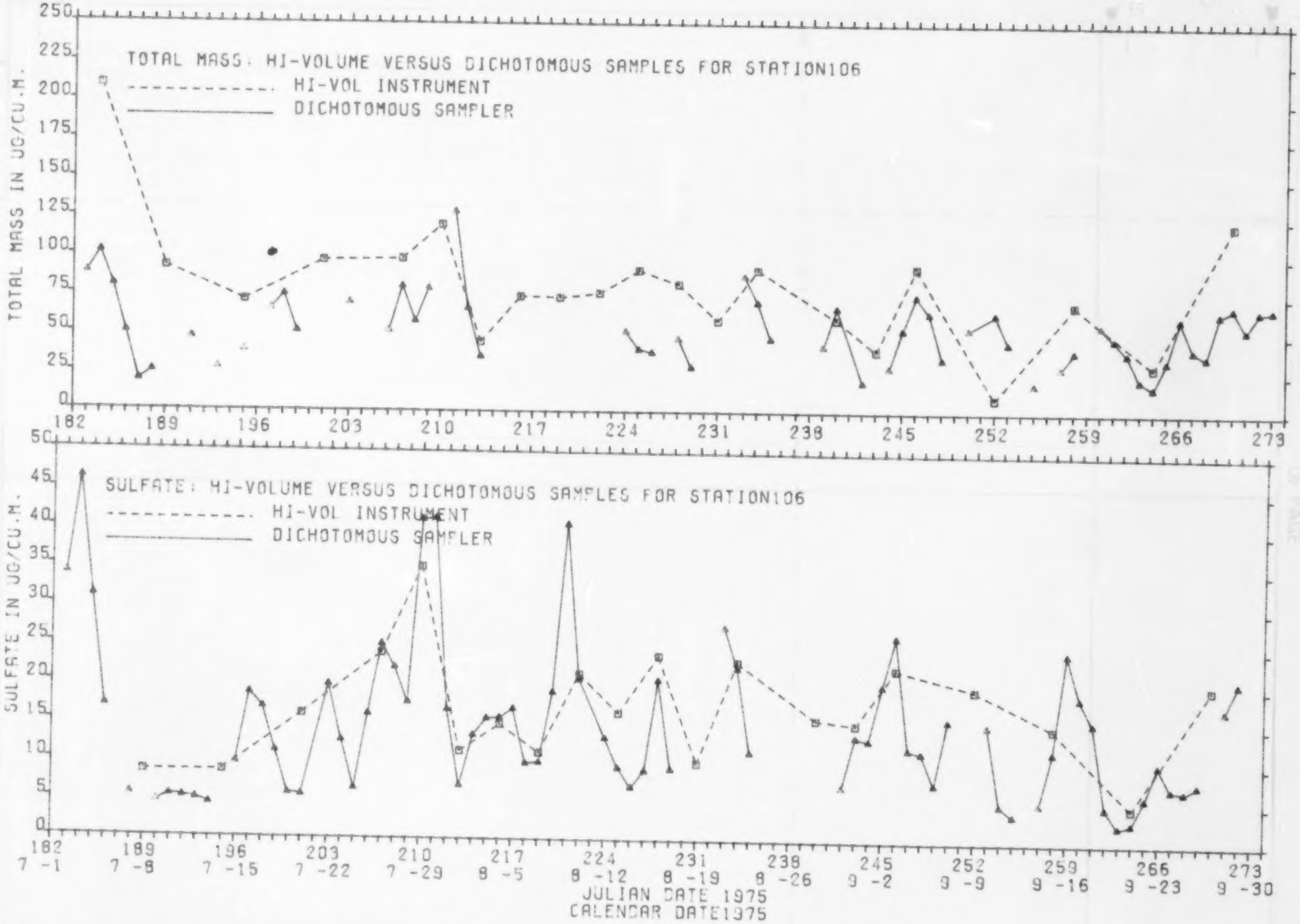


Figure C.18 Comparison of high volume versus dichotomous samples at station 106.

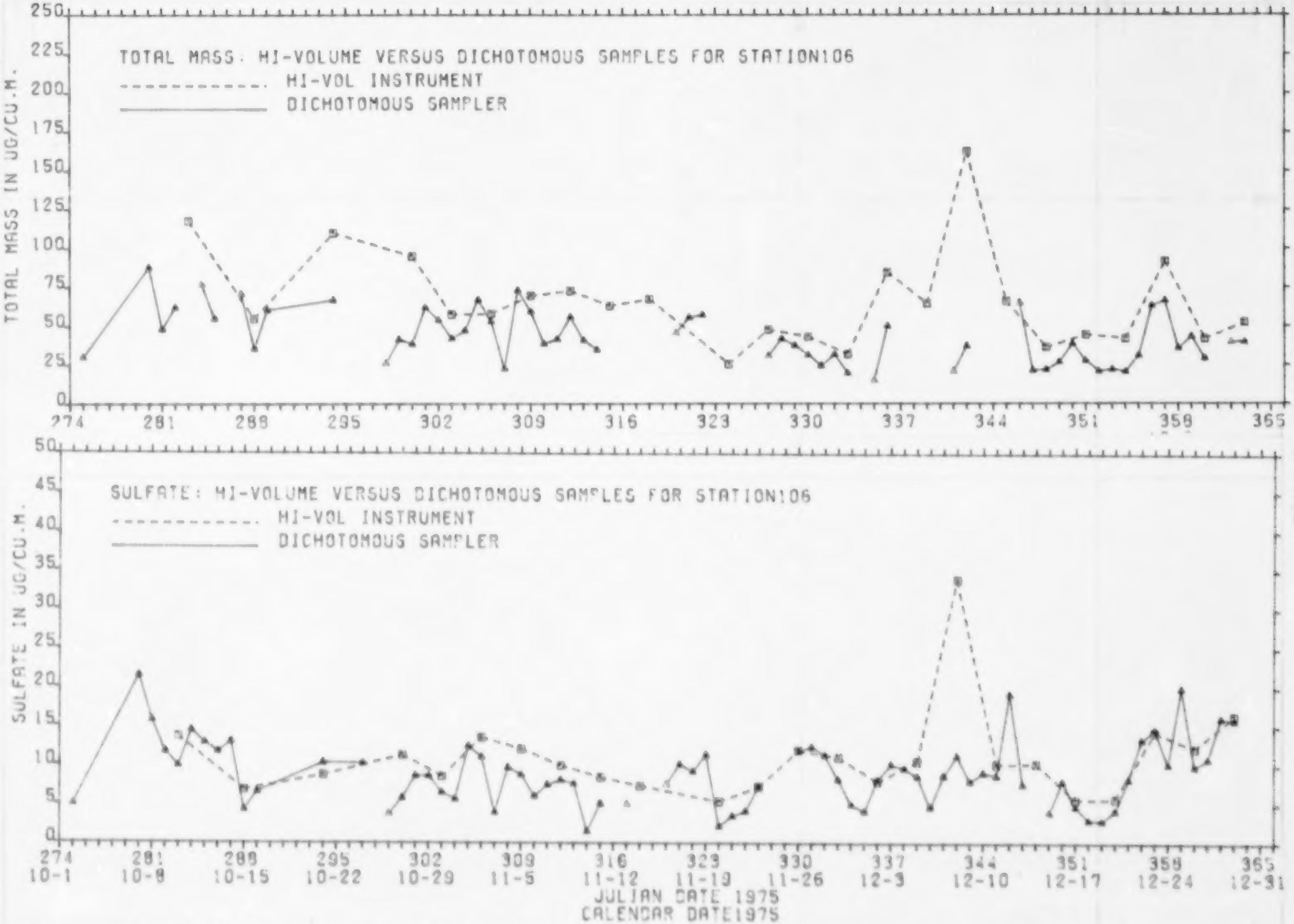


Figure C.19 Comparison of high volume versus dichotomous samples at station 106.

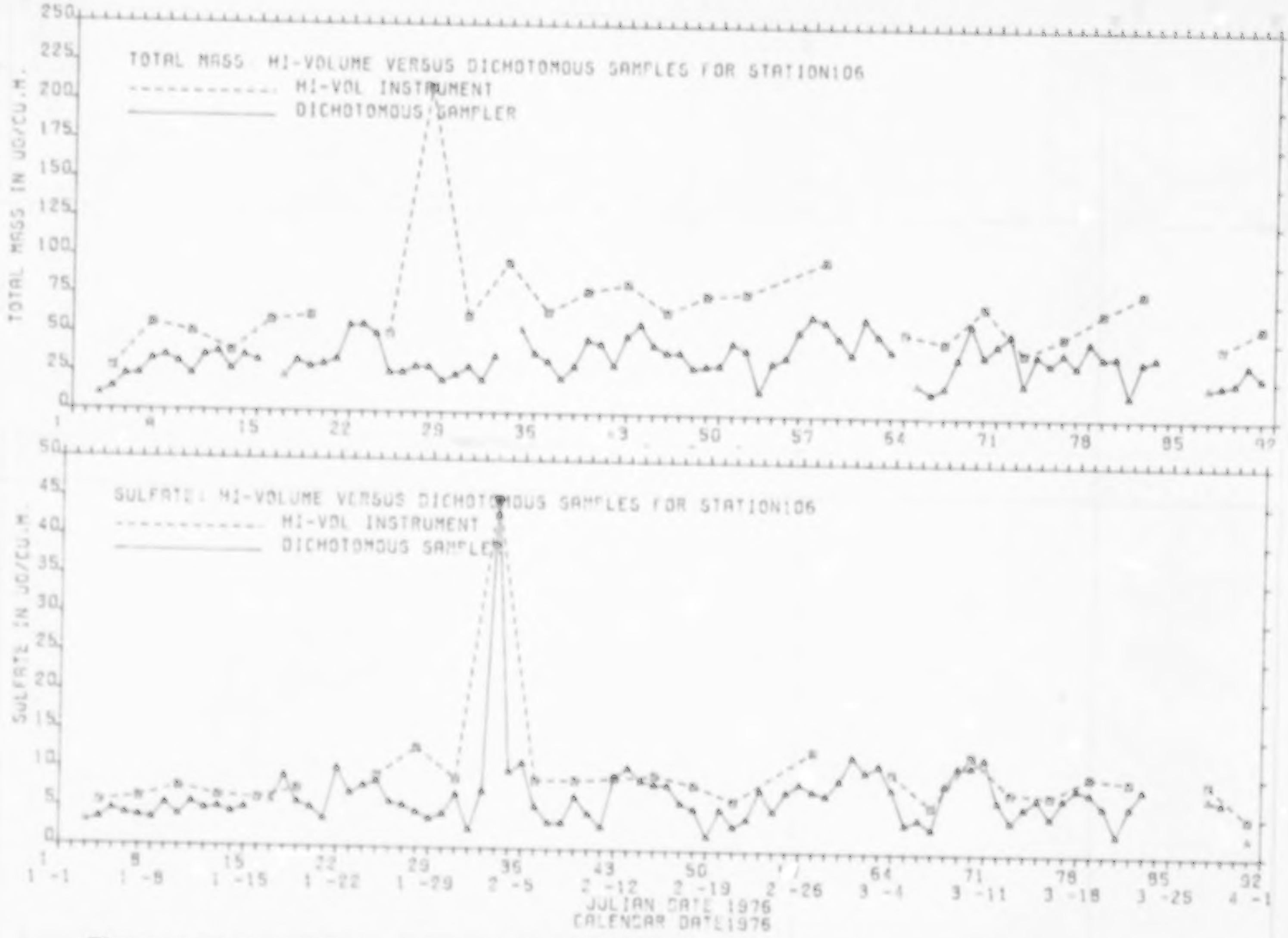


Figure C.20 Comparison of high volume versus dichotomous samples at station 106.

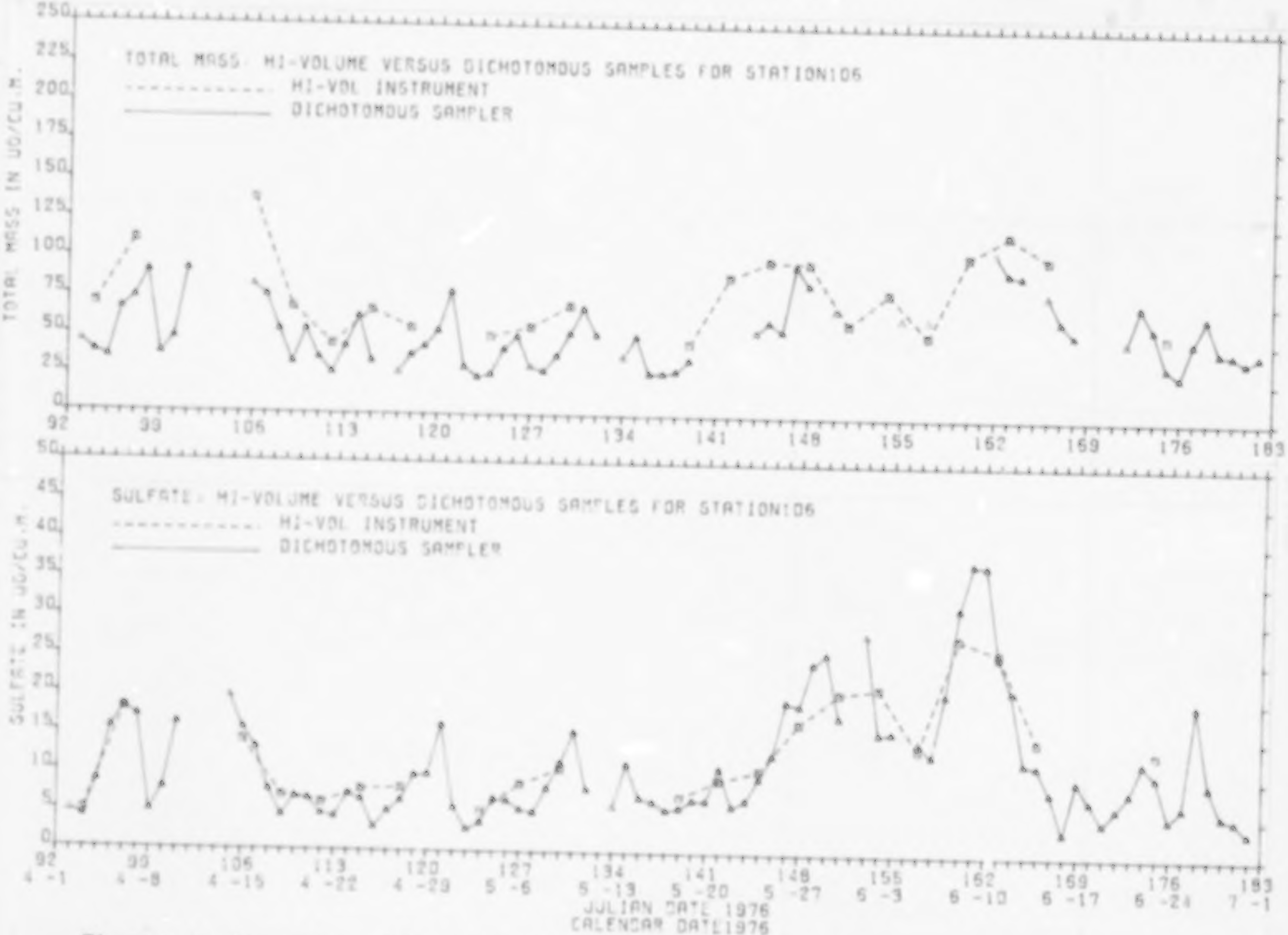


Figure C.21 Comparison of high volume versus dichotomous samples at station 106.

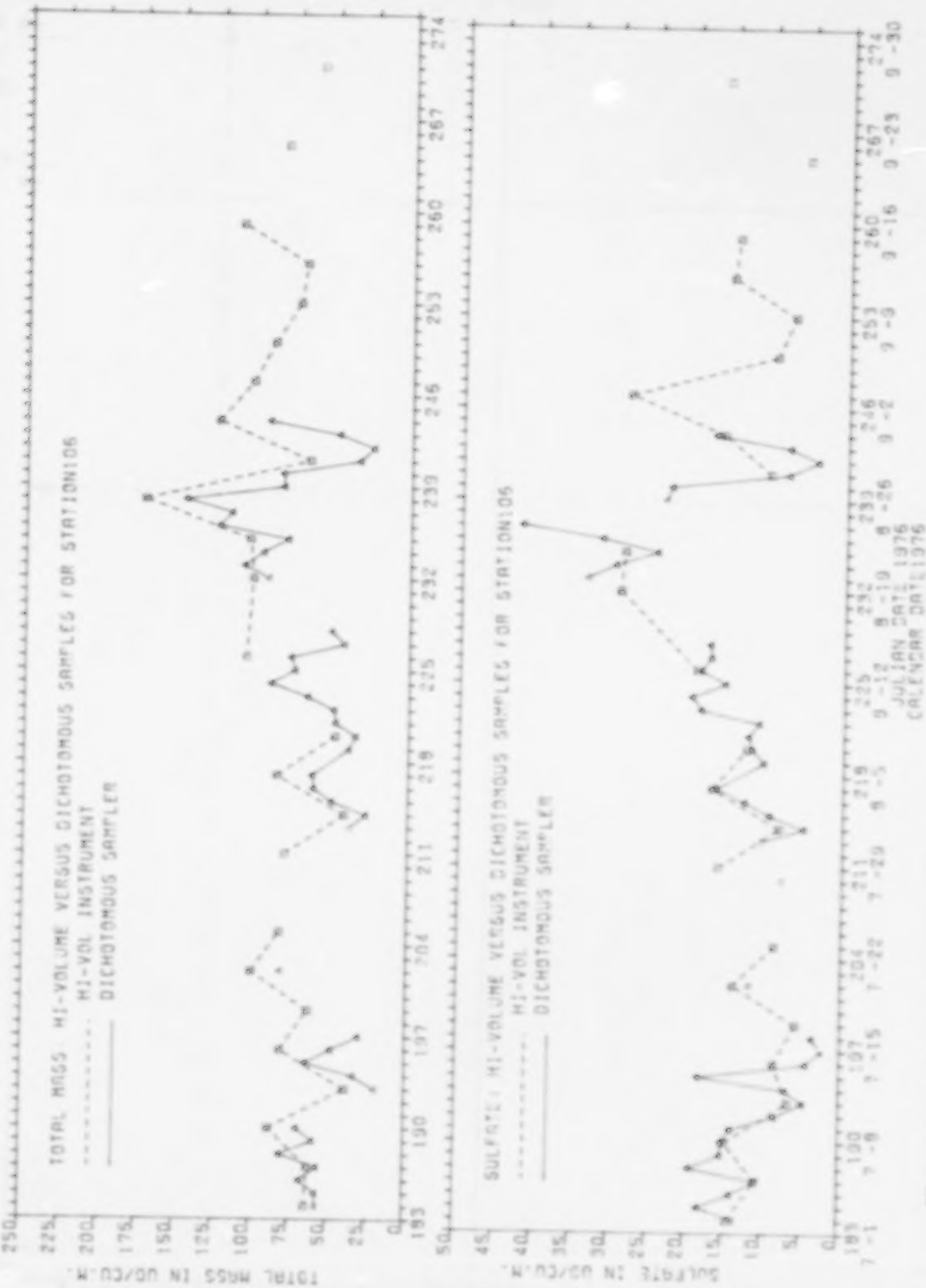
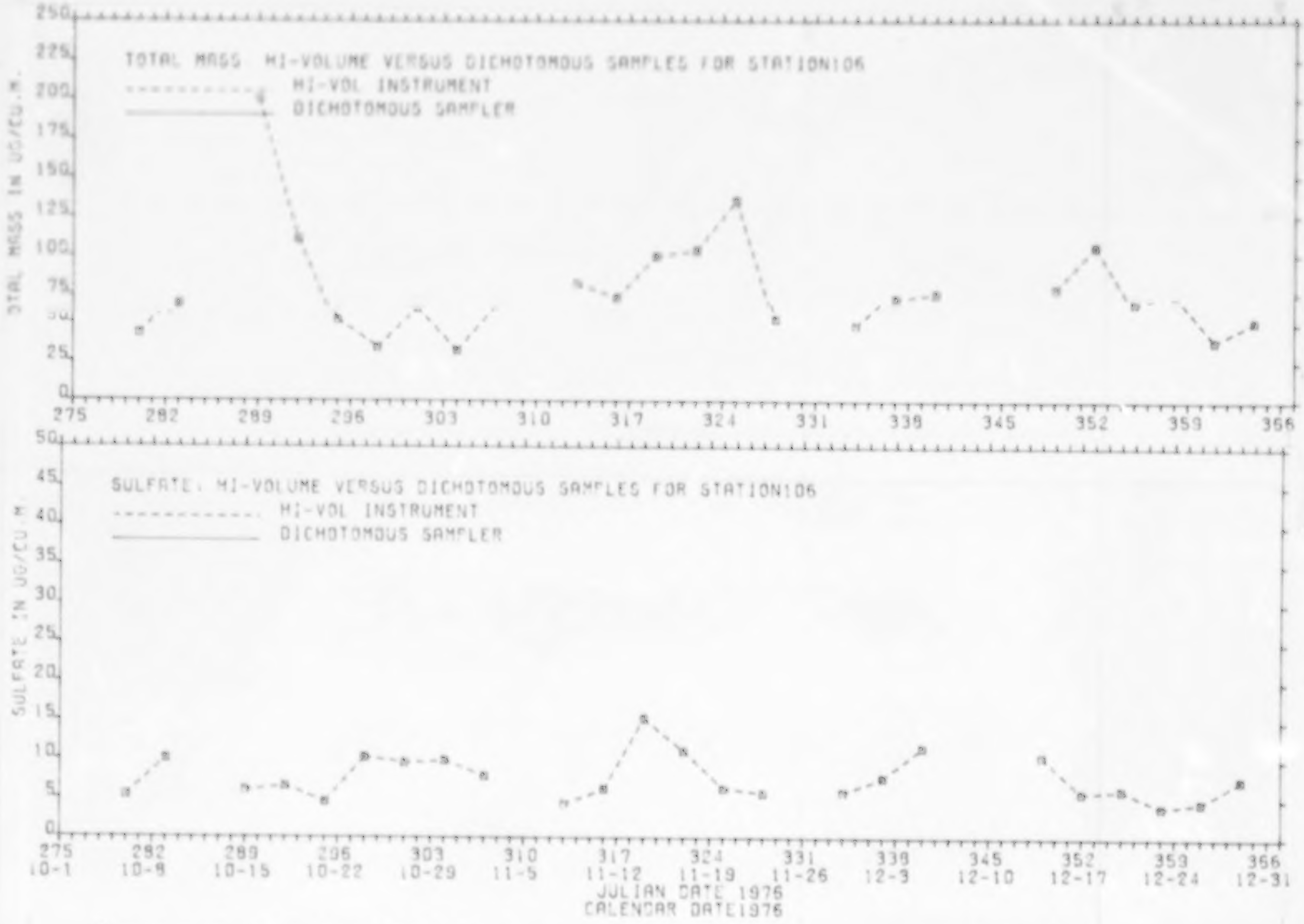


Figure C.22 Comparison of high volume versus dichotomous samples at station 106.



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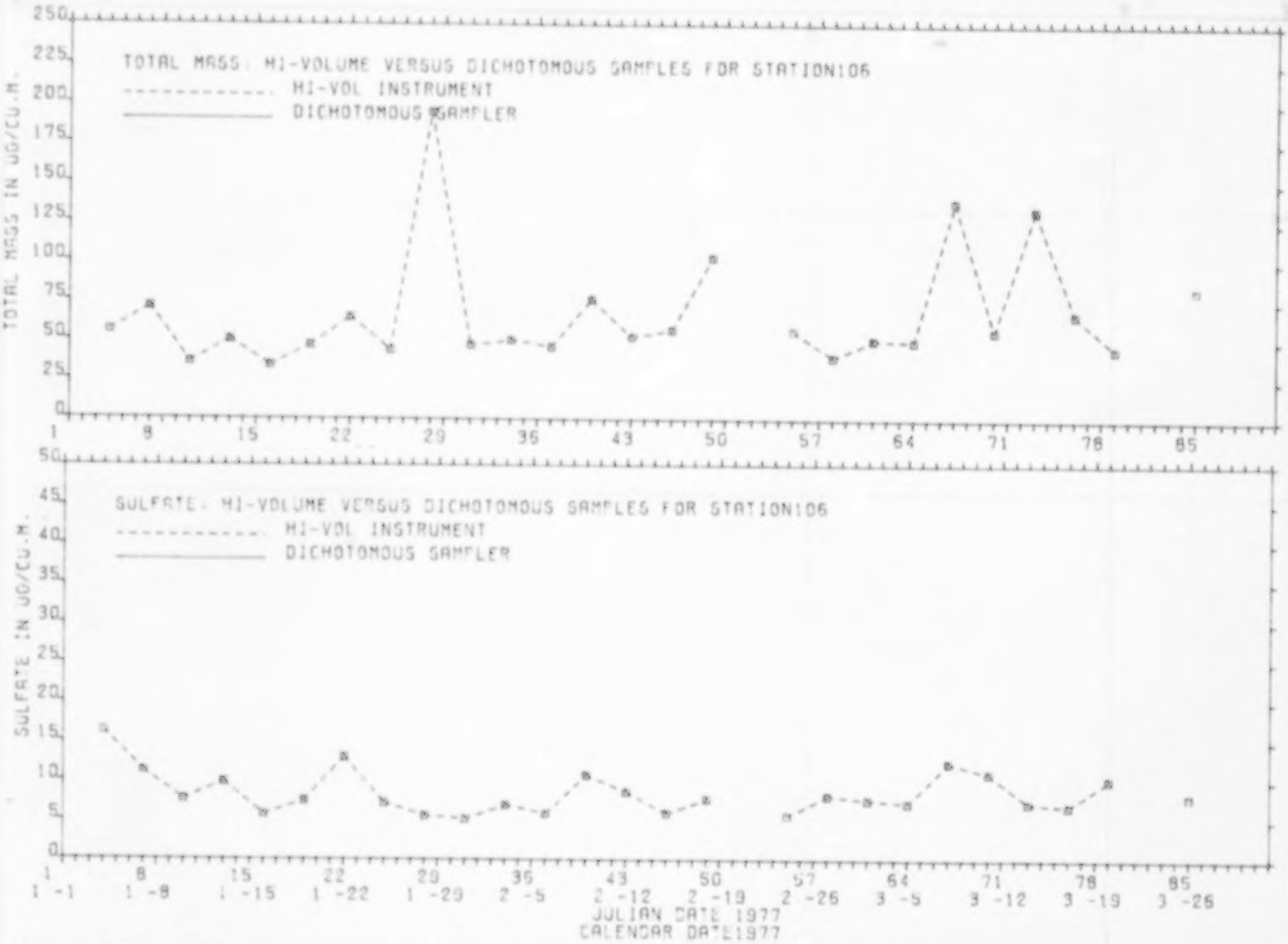


Figure C.24 Comparison of high volume versus dichotomous samples at station 106.

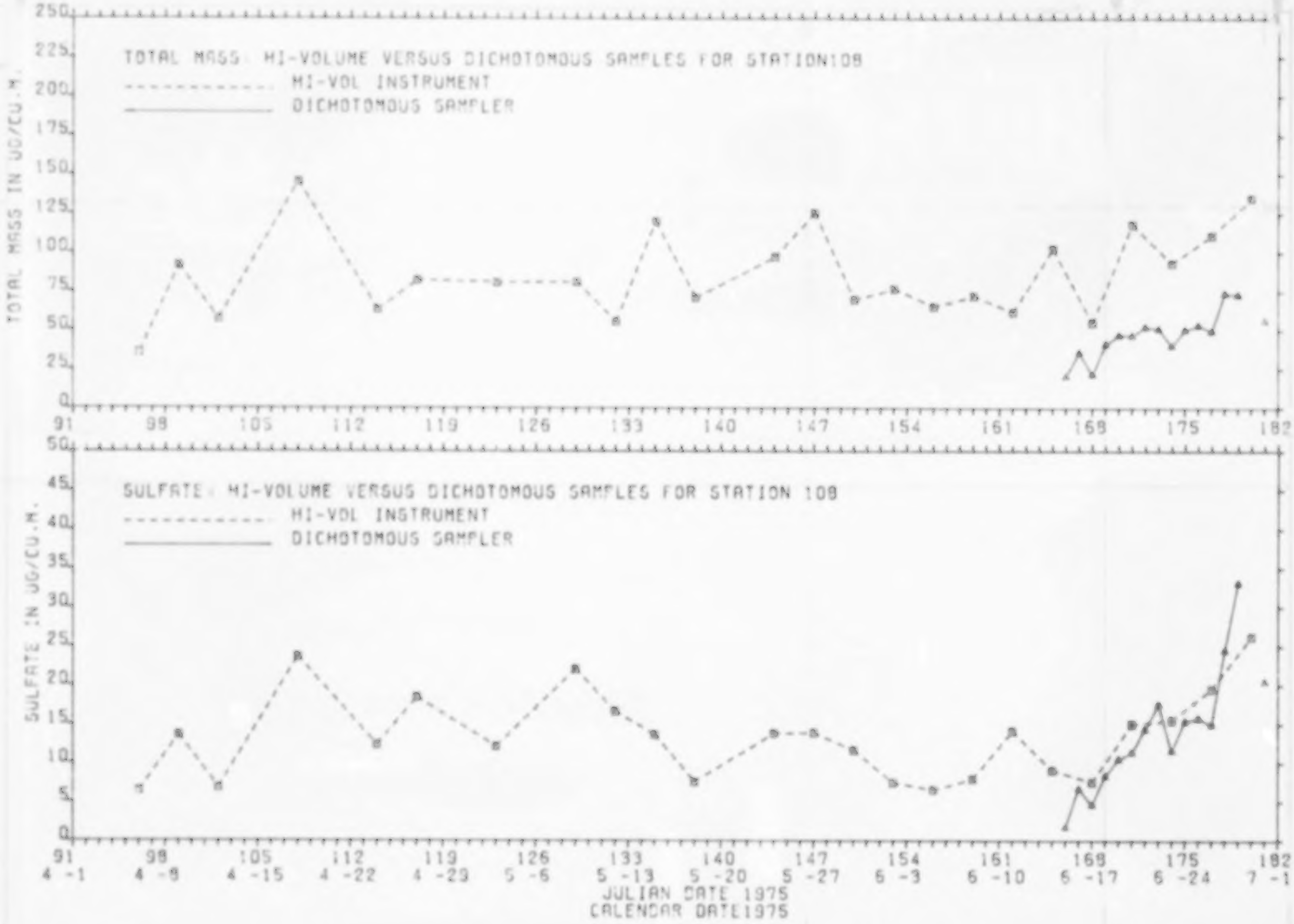


Figure C.25 Comparison of high volume versus dichotomous samples at station 108.

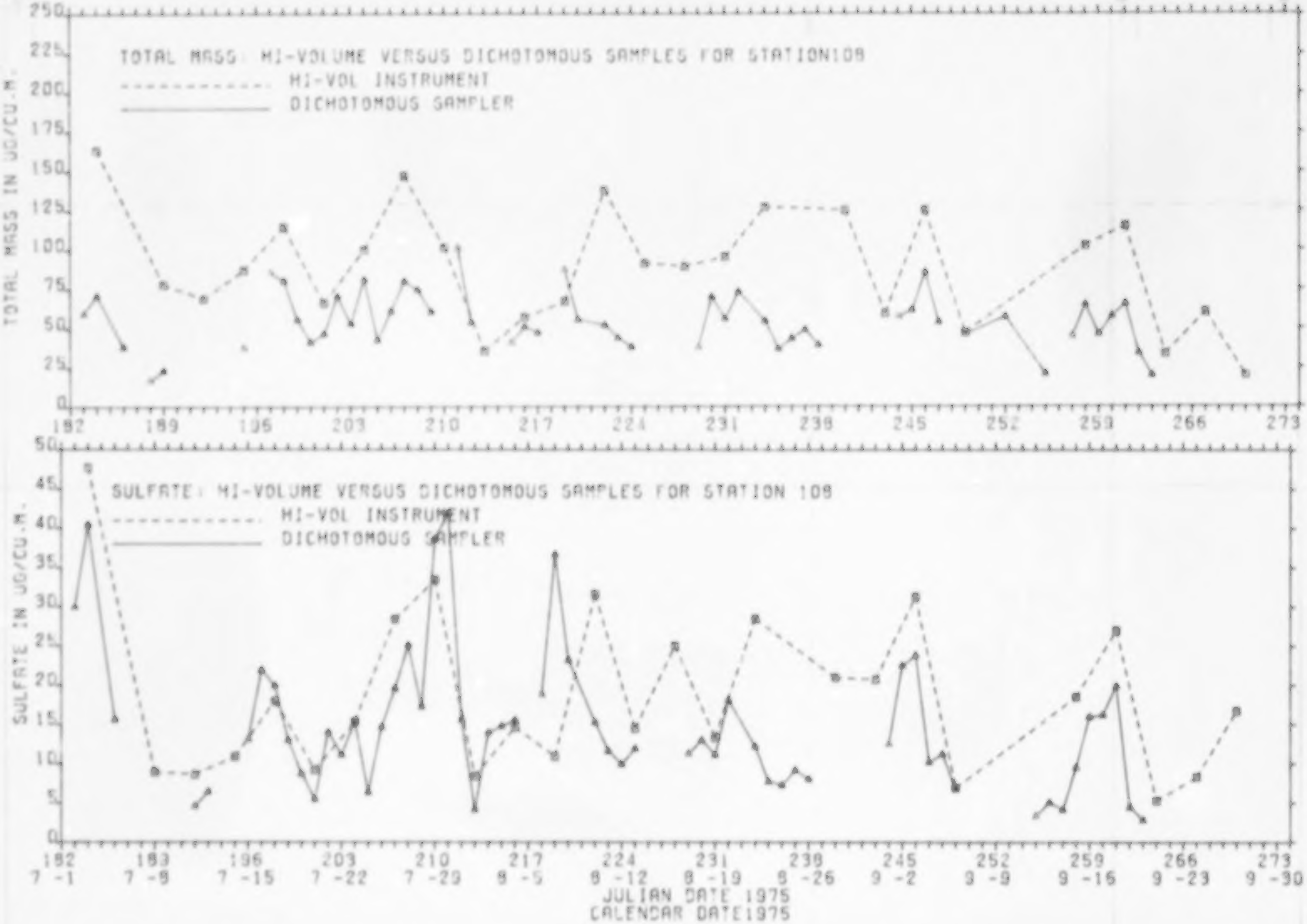


Figure C.26 Comparison of high volume versus dichotomous samples at station 108.

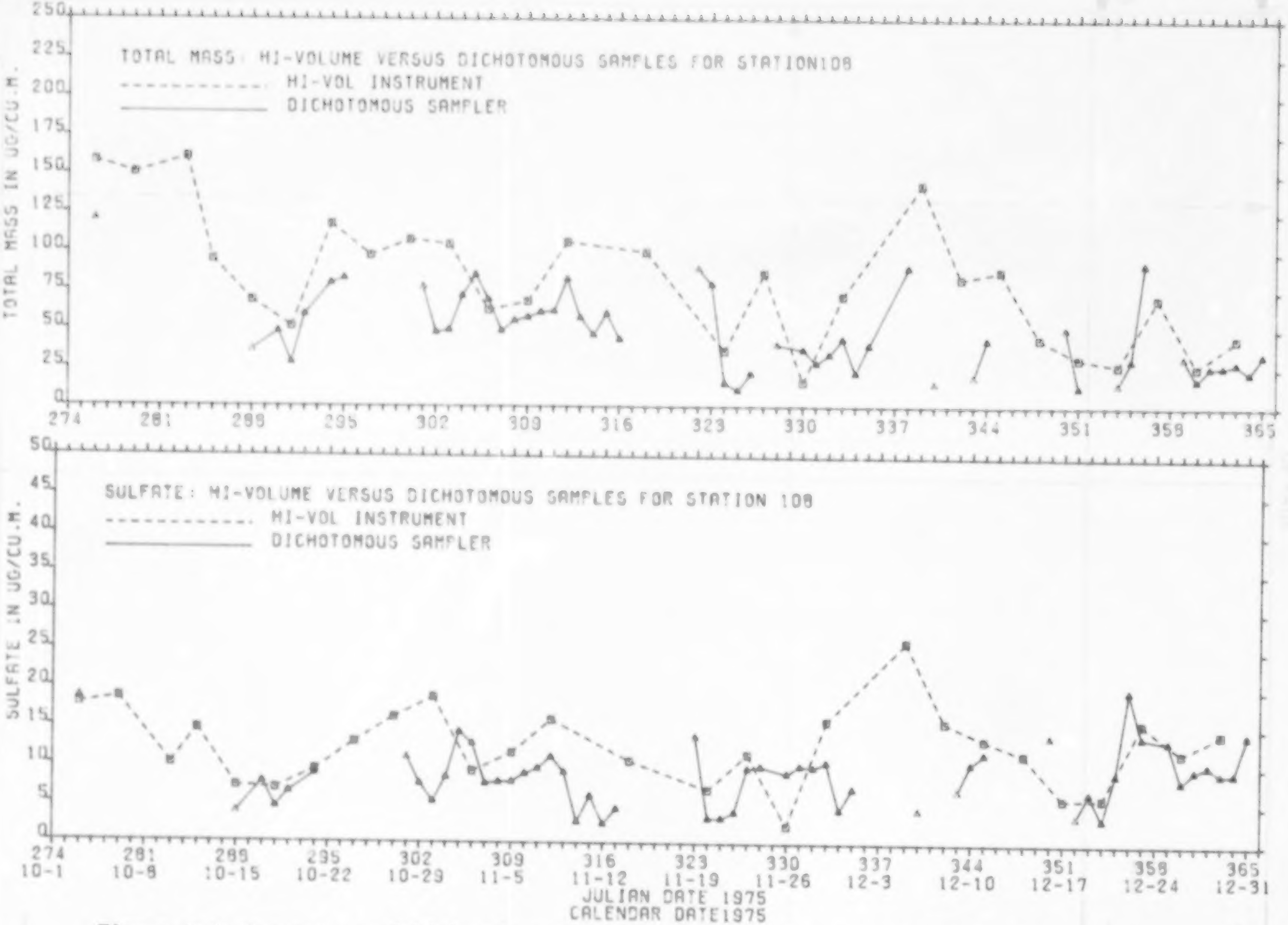


Figure C.27 Comparison of high volume versus dichotomous samples at station 108.

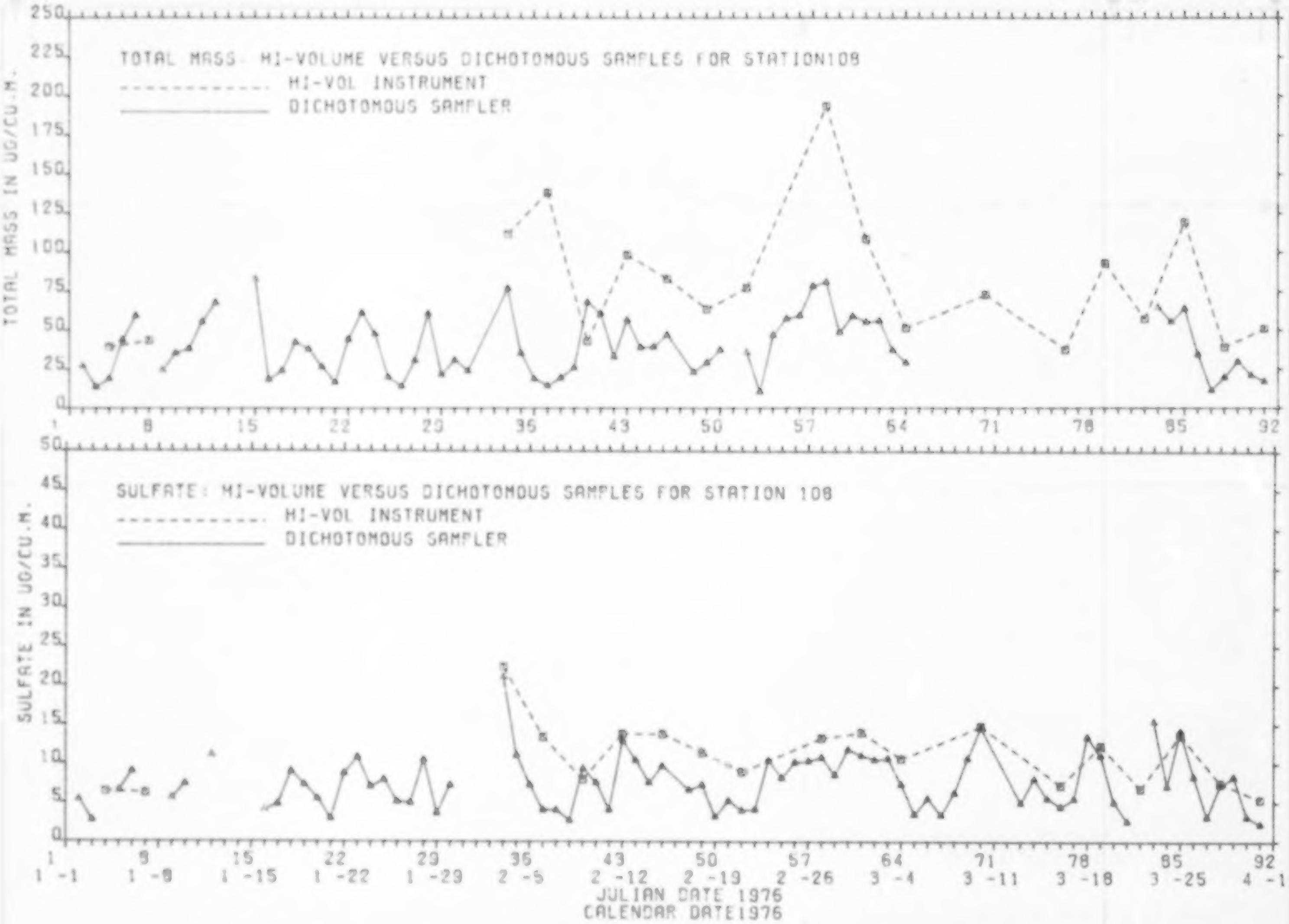
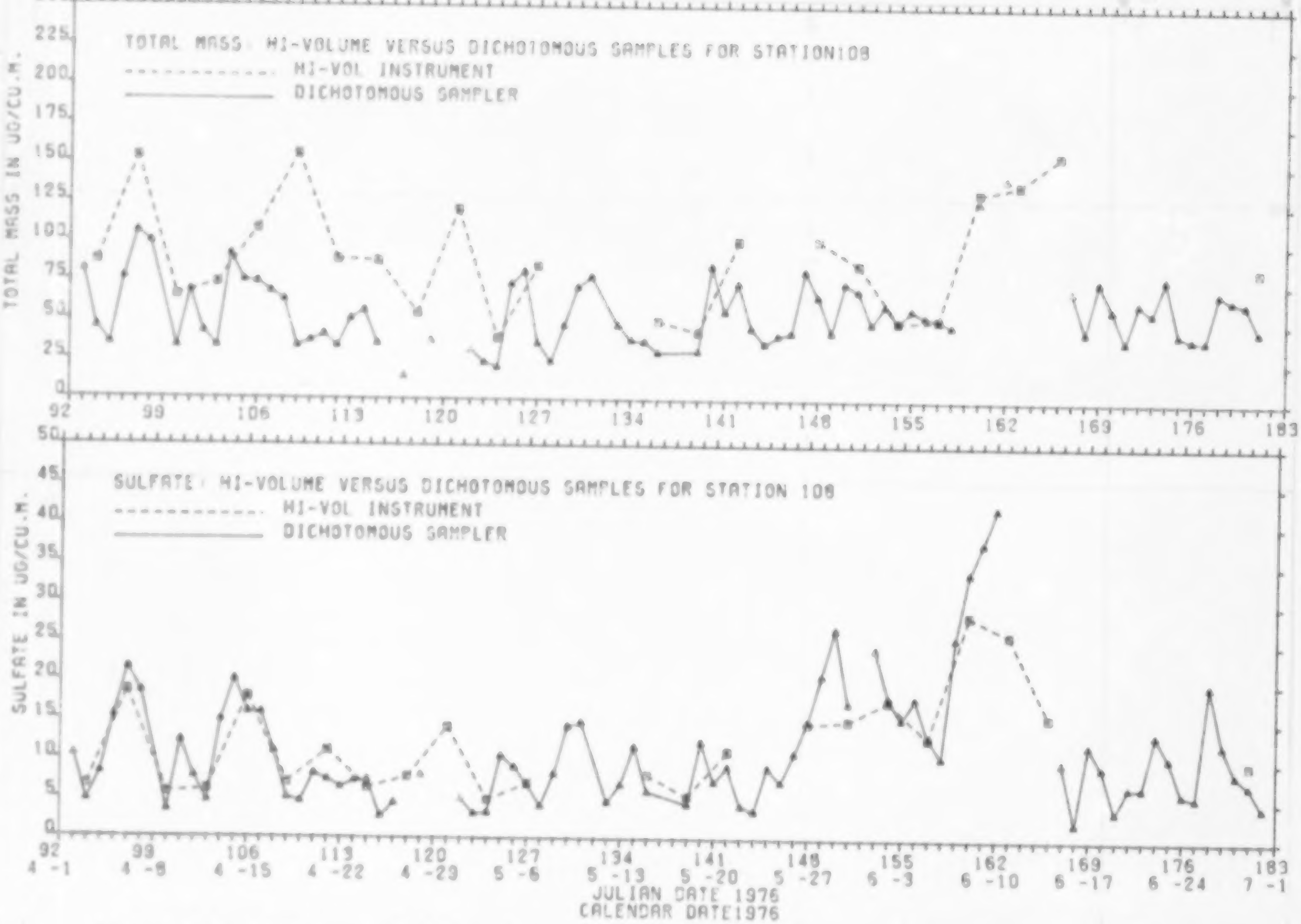


Figure C.28 Comparison of high volume versus dichotomous samples at station 108.



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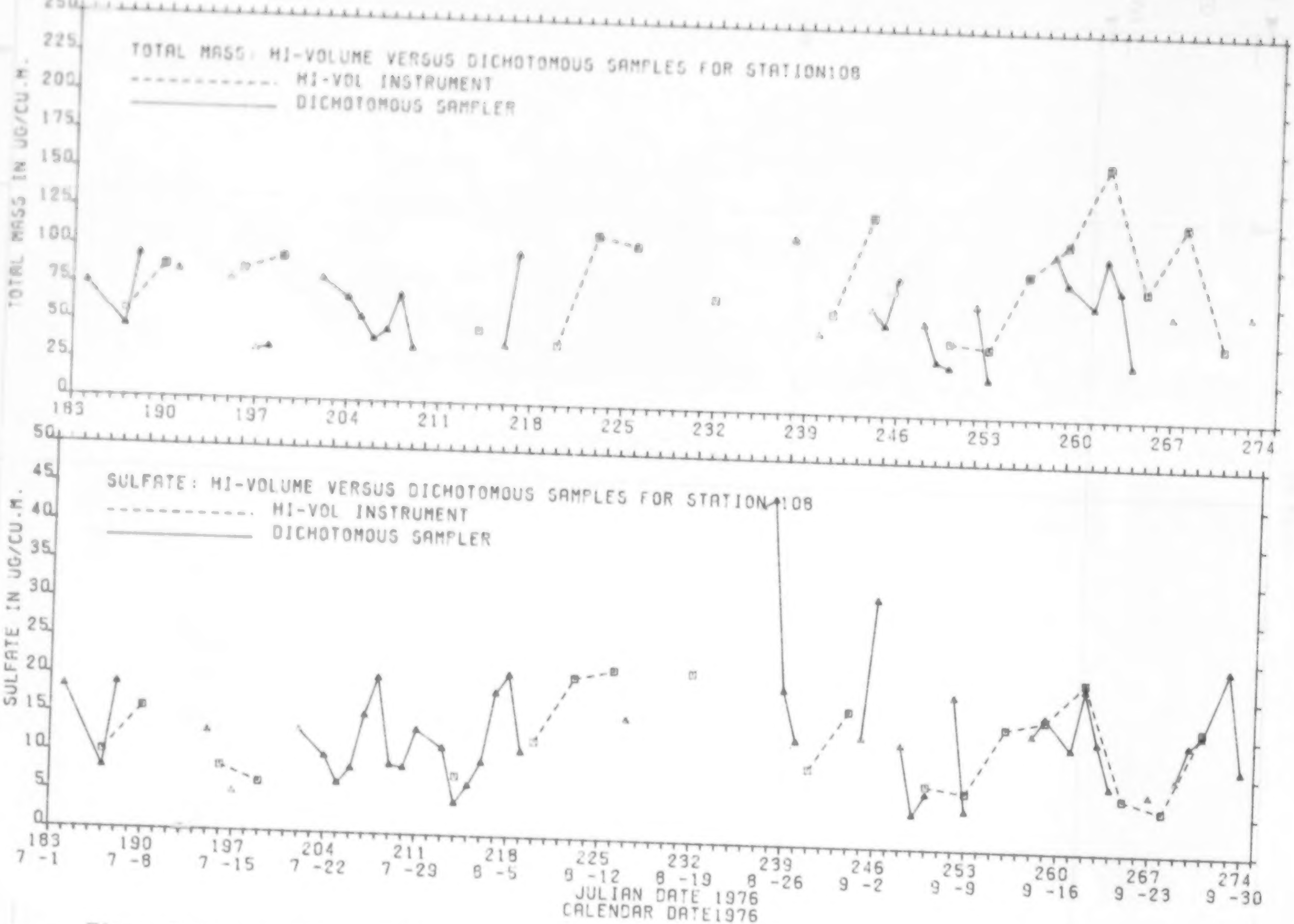

Figure C.30 Comparison of high volume versus dichotomous samples at station 108.

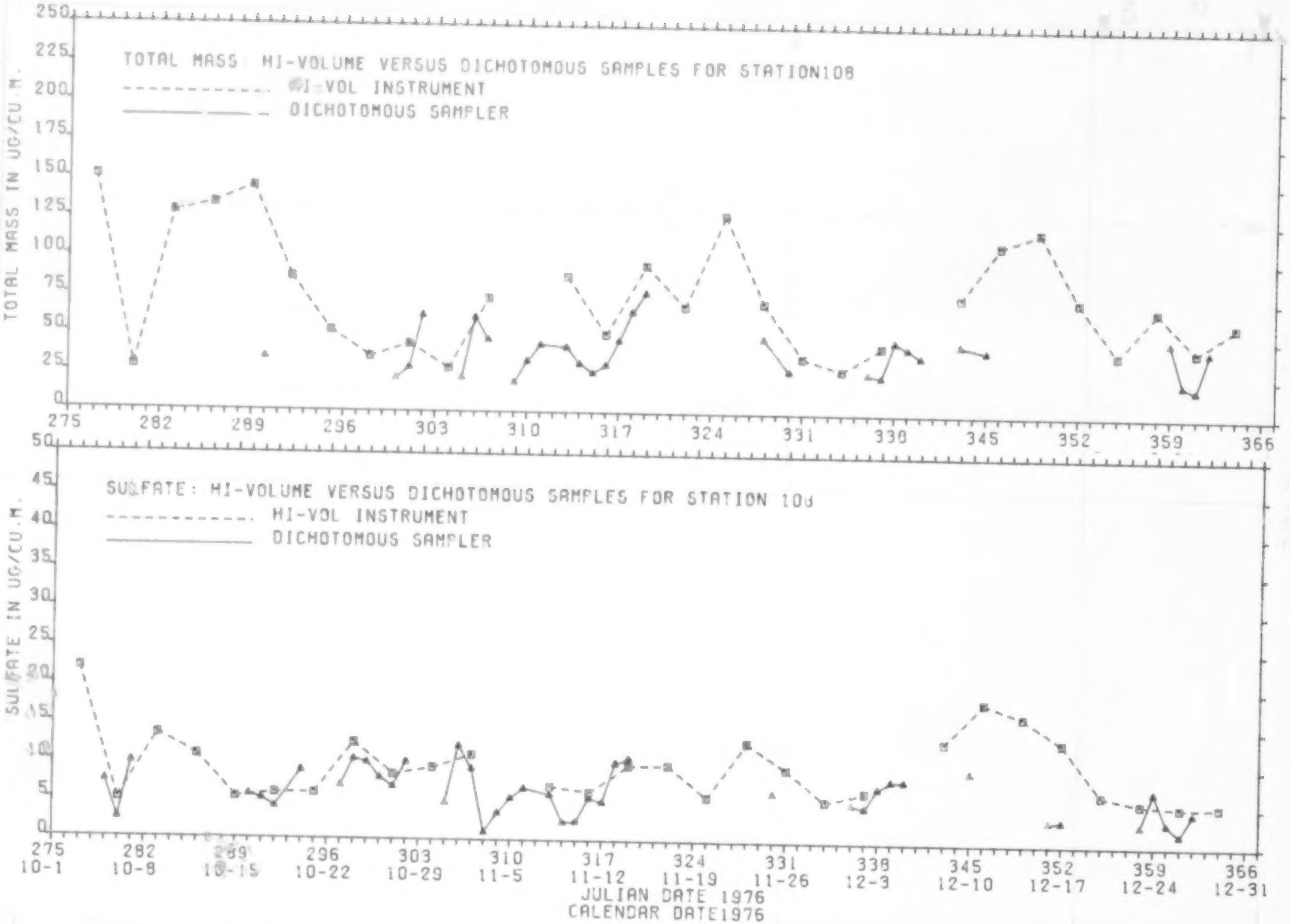

Figure C.31 Comparison of high volume versus dichotomous samples at station 108.

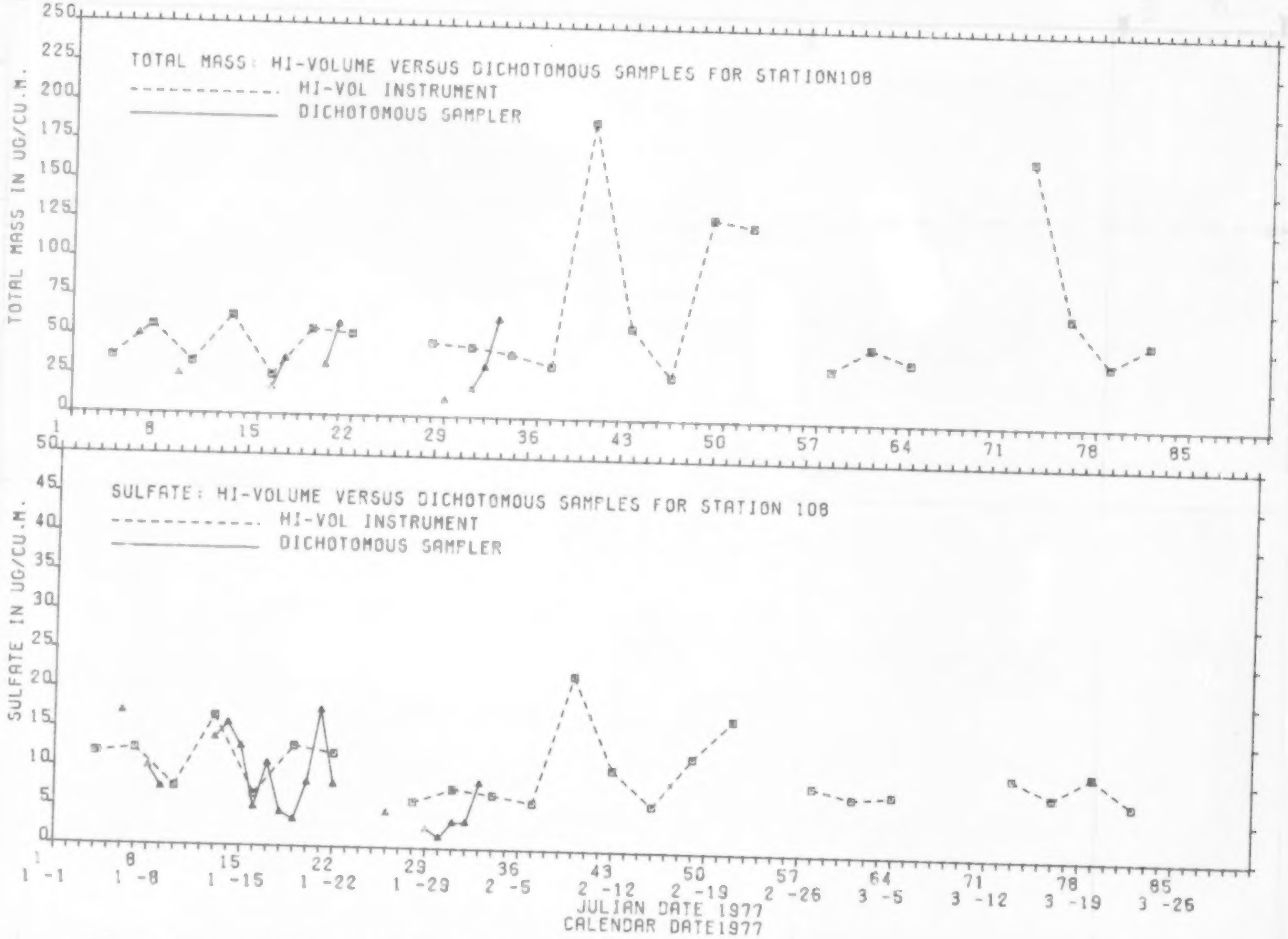

Figure C.32 Comparison of high volume versus dichotomous samples at station 108.

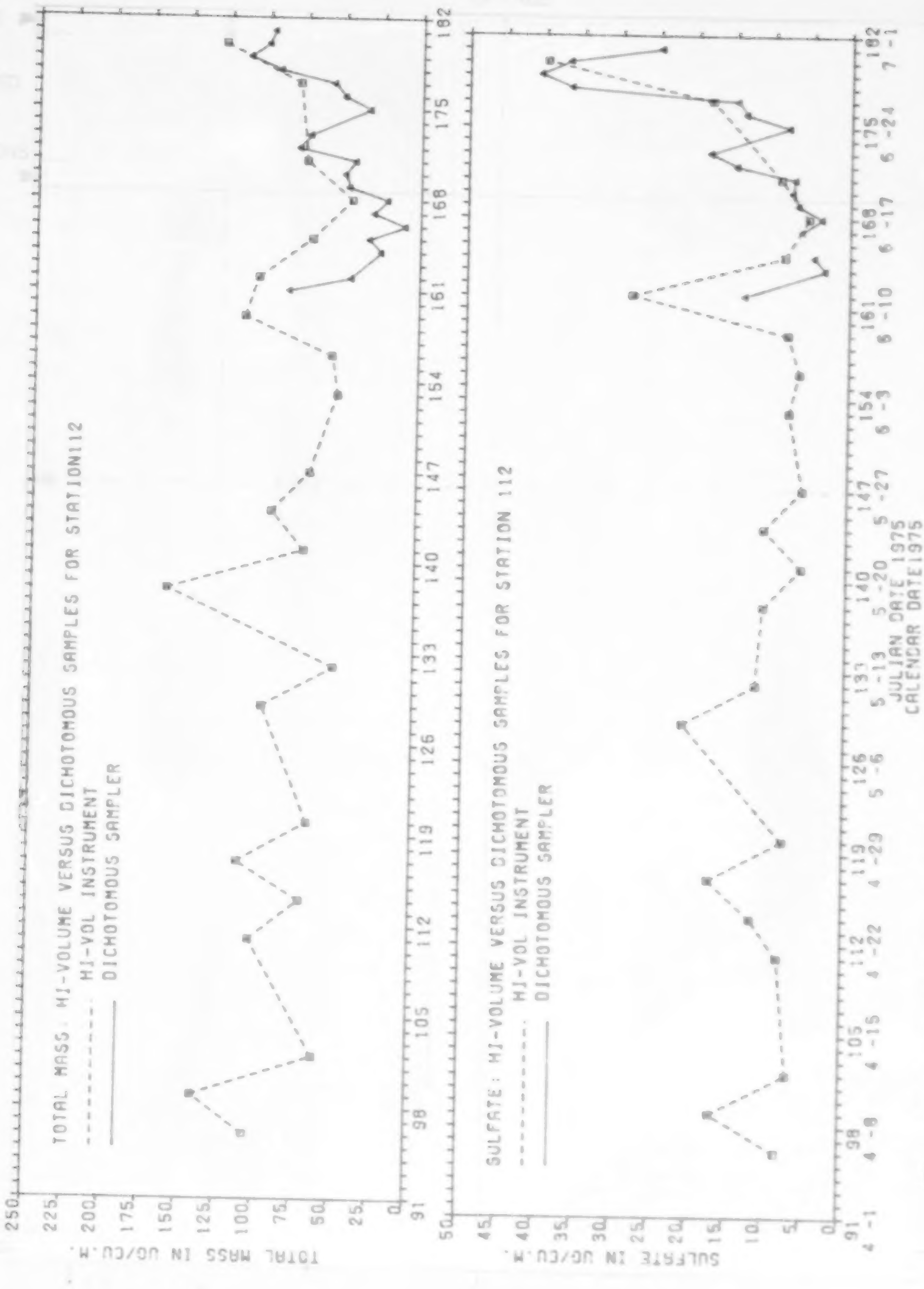

Figure C.33 Comparison of high volume versus dichotomous samples at station 112.

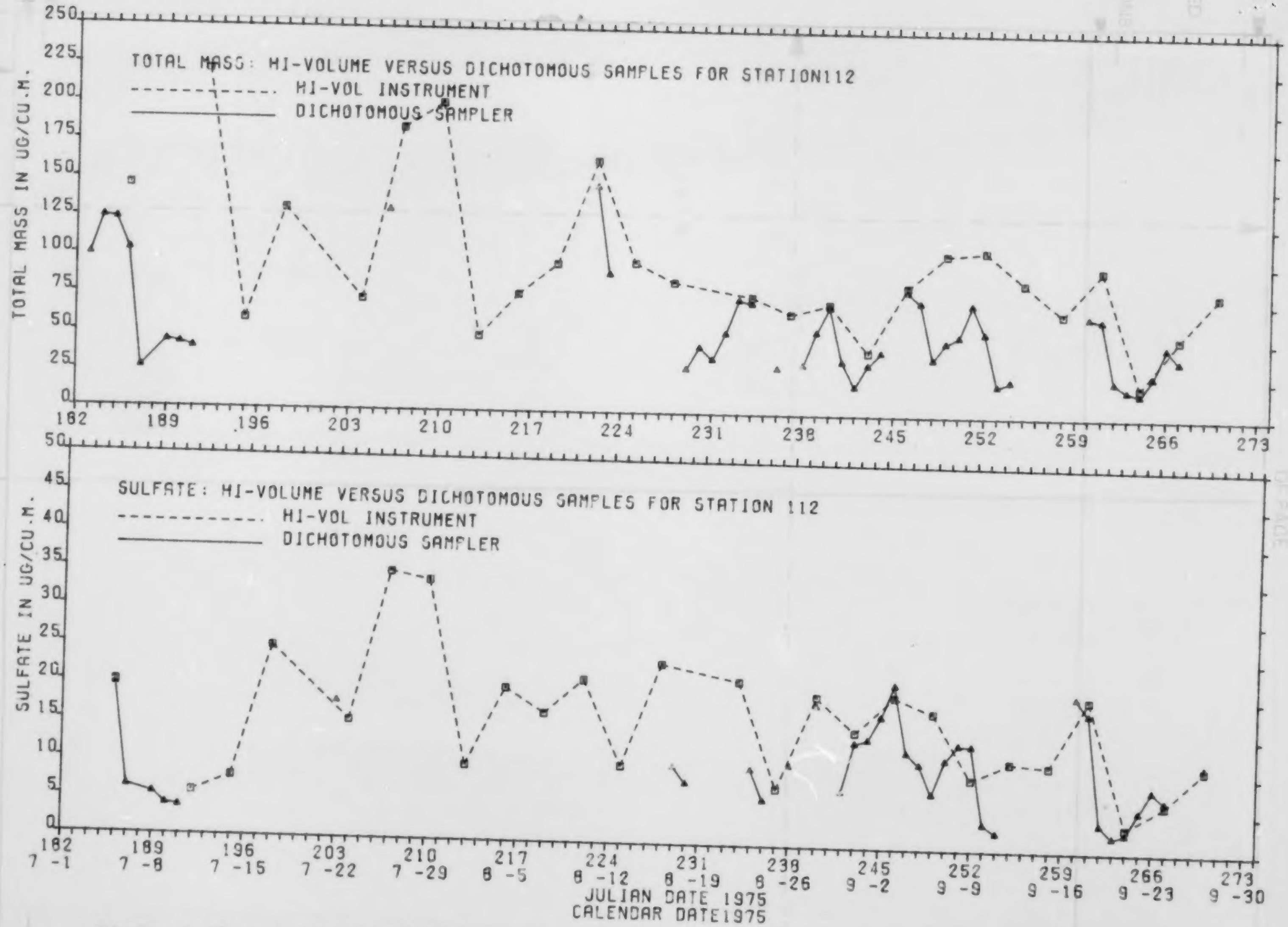

Figure C.34 Comparison of high volume versus dichotomous samples at station 112.

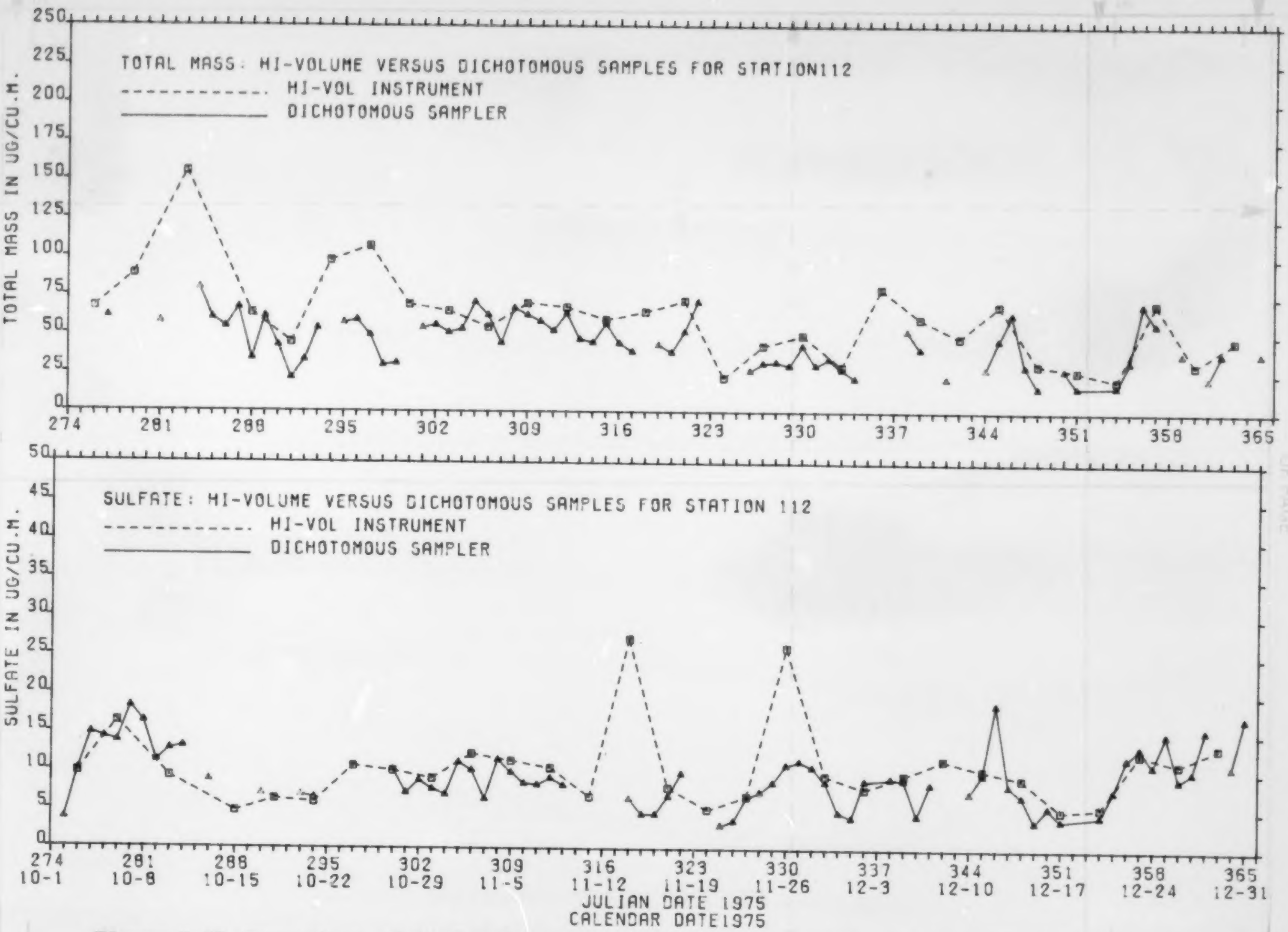

Figure C.35 Comparison of high volume versus dichotomous samples at station 112.

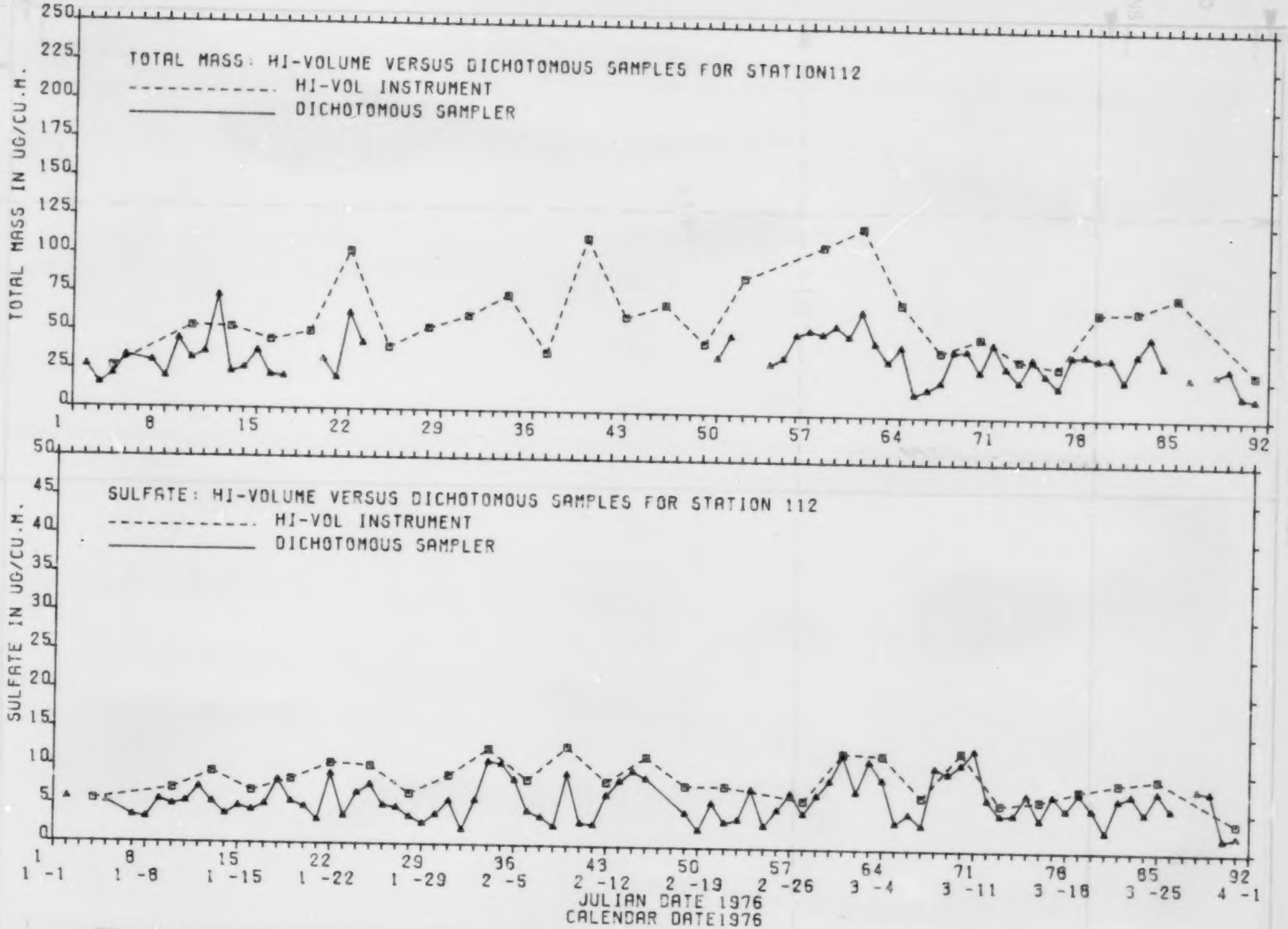

Figure C.36 Comparison of high volume versus dichotomous samples at station 112.

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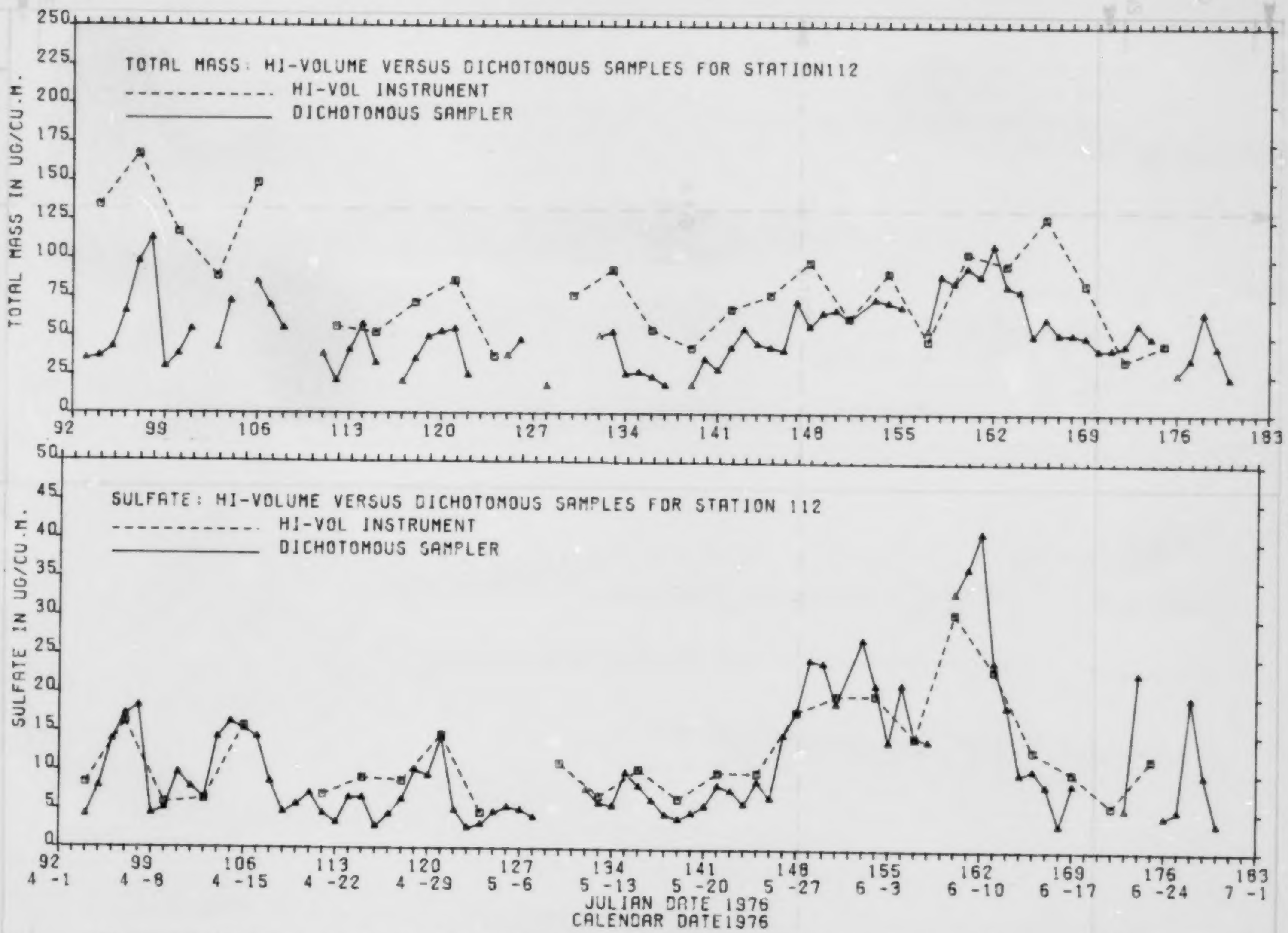

Figure C.37 Comparison of high volume versus dichotomous samples at station 112.

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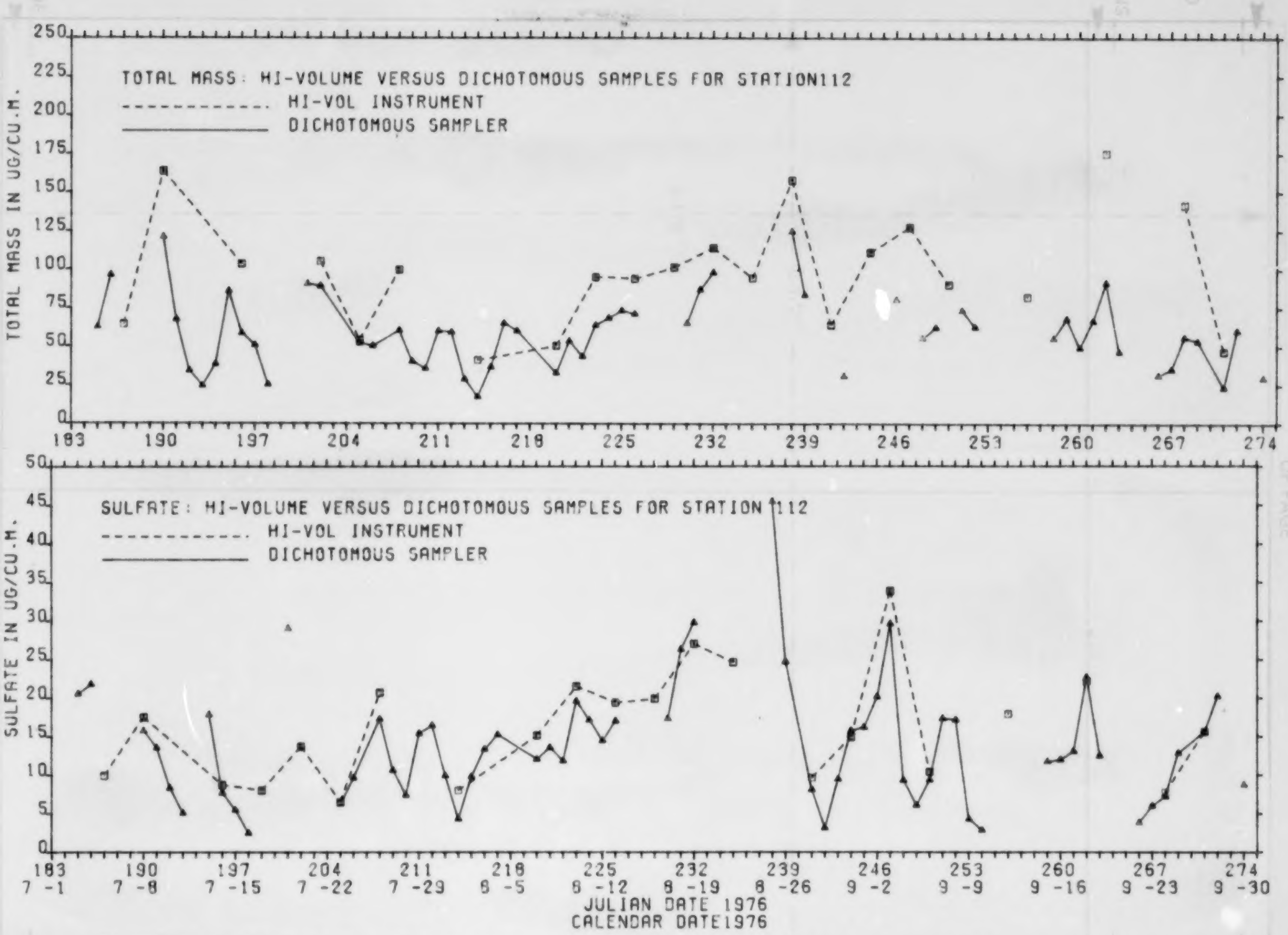

Figure C.38 Comparison of high volume versus dichotomous samples at station 112.

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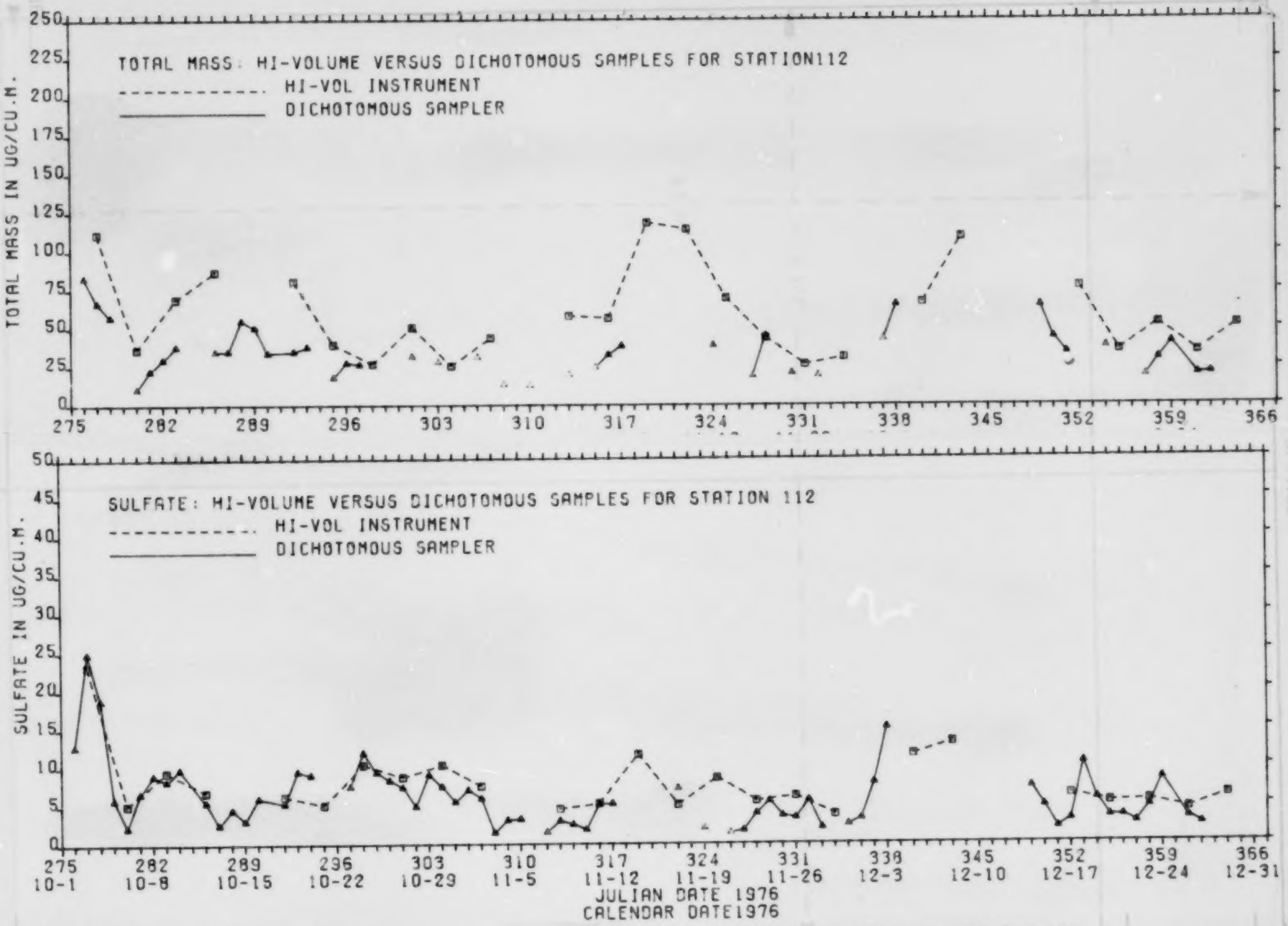

Figure C.39 Comparison of high volume versus dichotomous samples at station 112.

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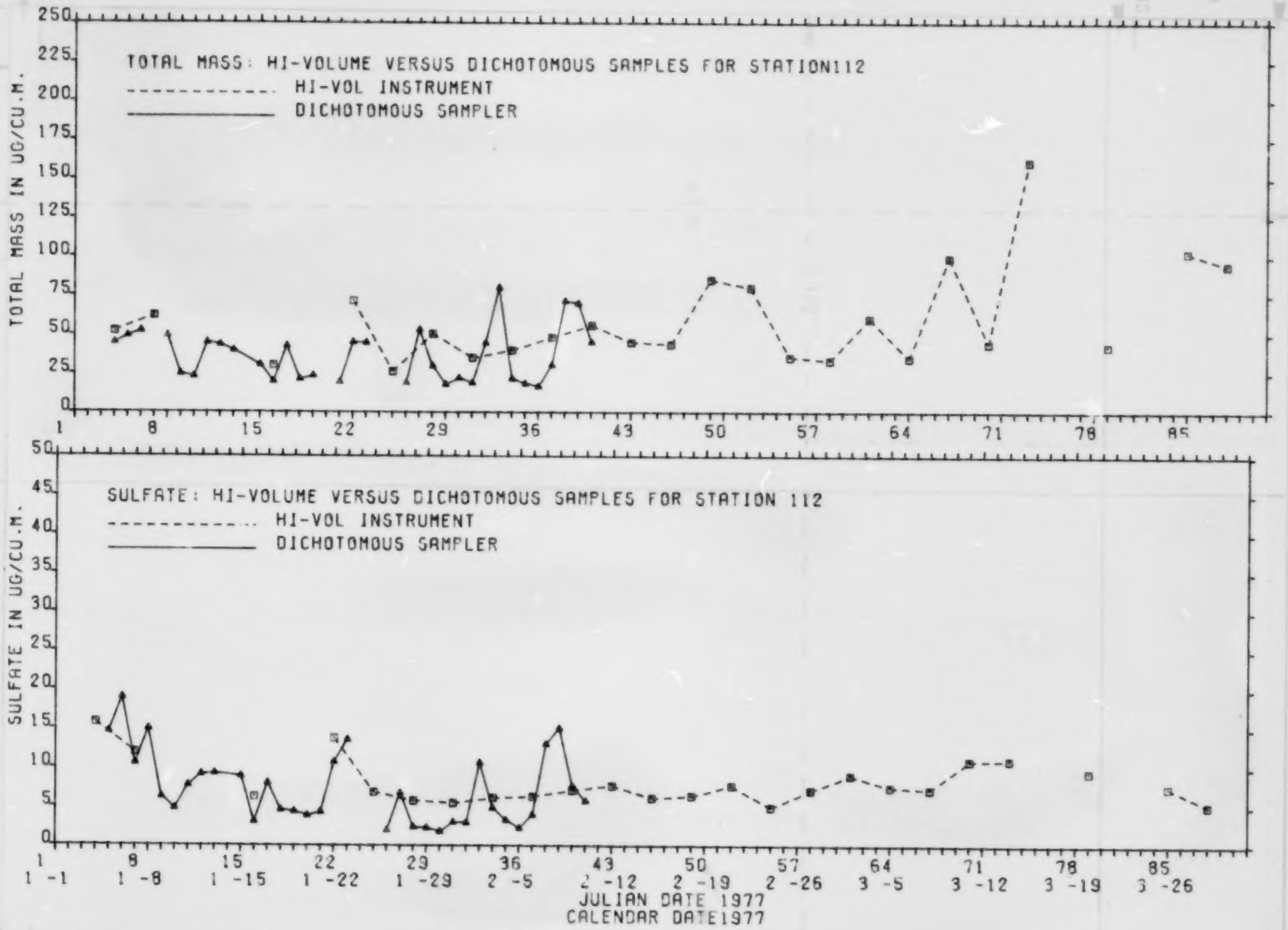

Figure C.40 Comparison of high volume versus dichotomous samples at station 112.

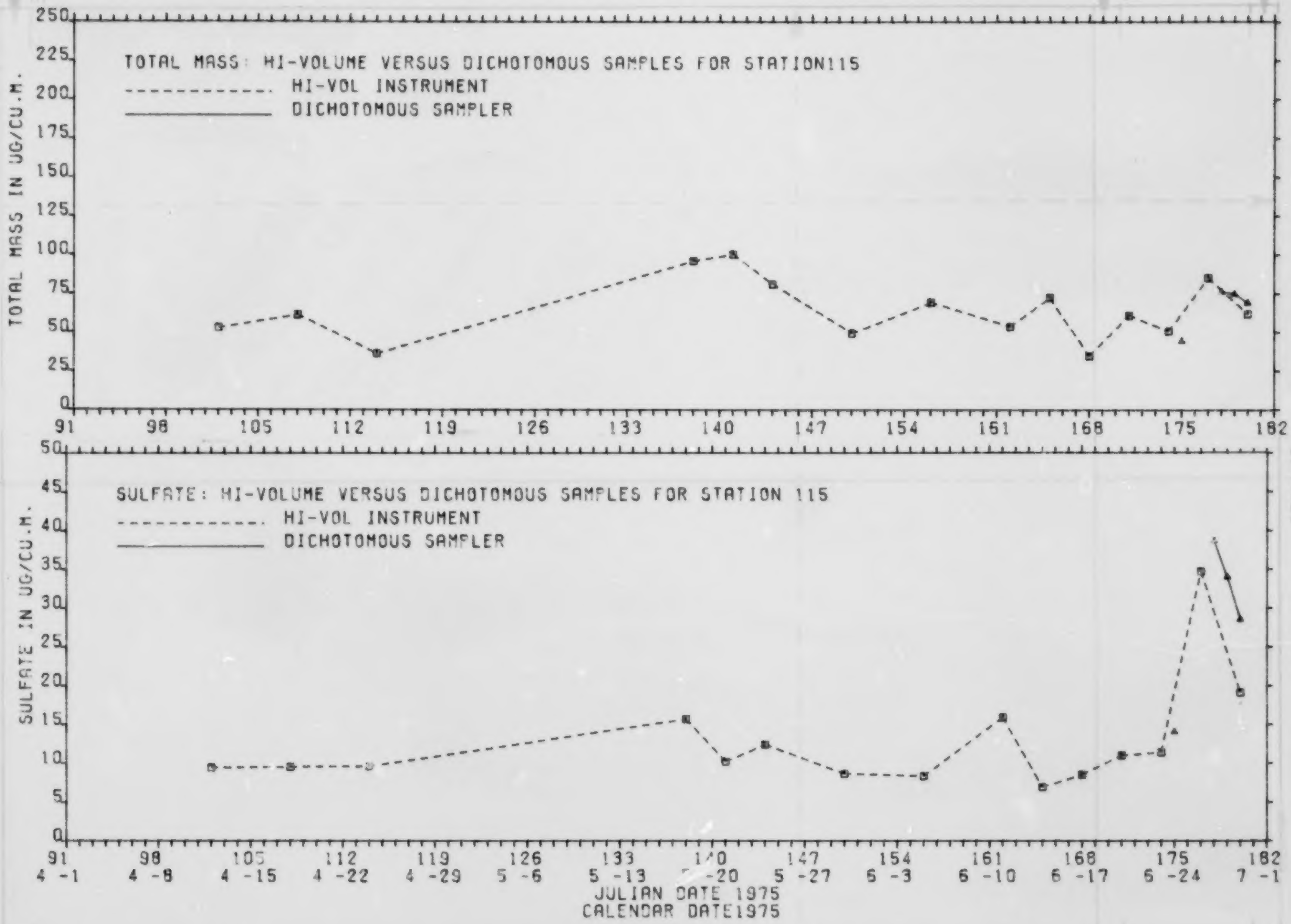

Figure C.41 Comparison of high volume versus dichotomous samples at station 115.

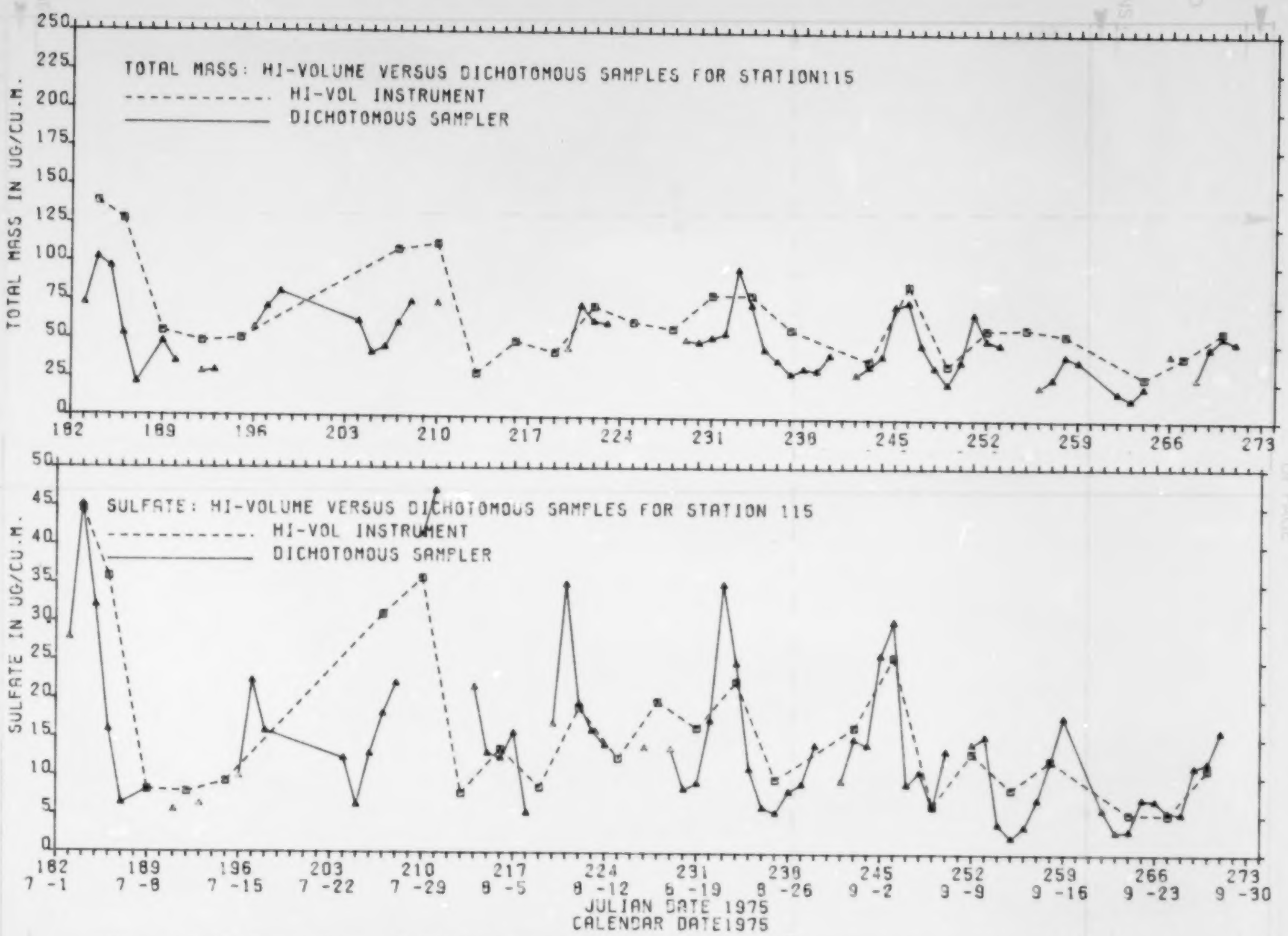

Figure C.42 Comparison of high volume versus dichotomous samples at station 115.

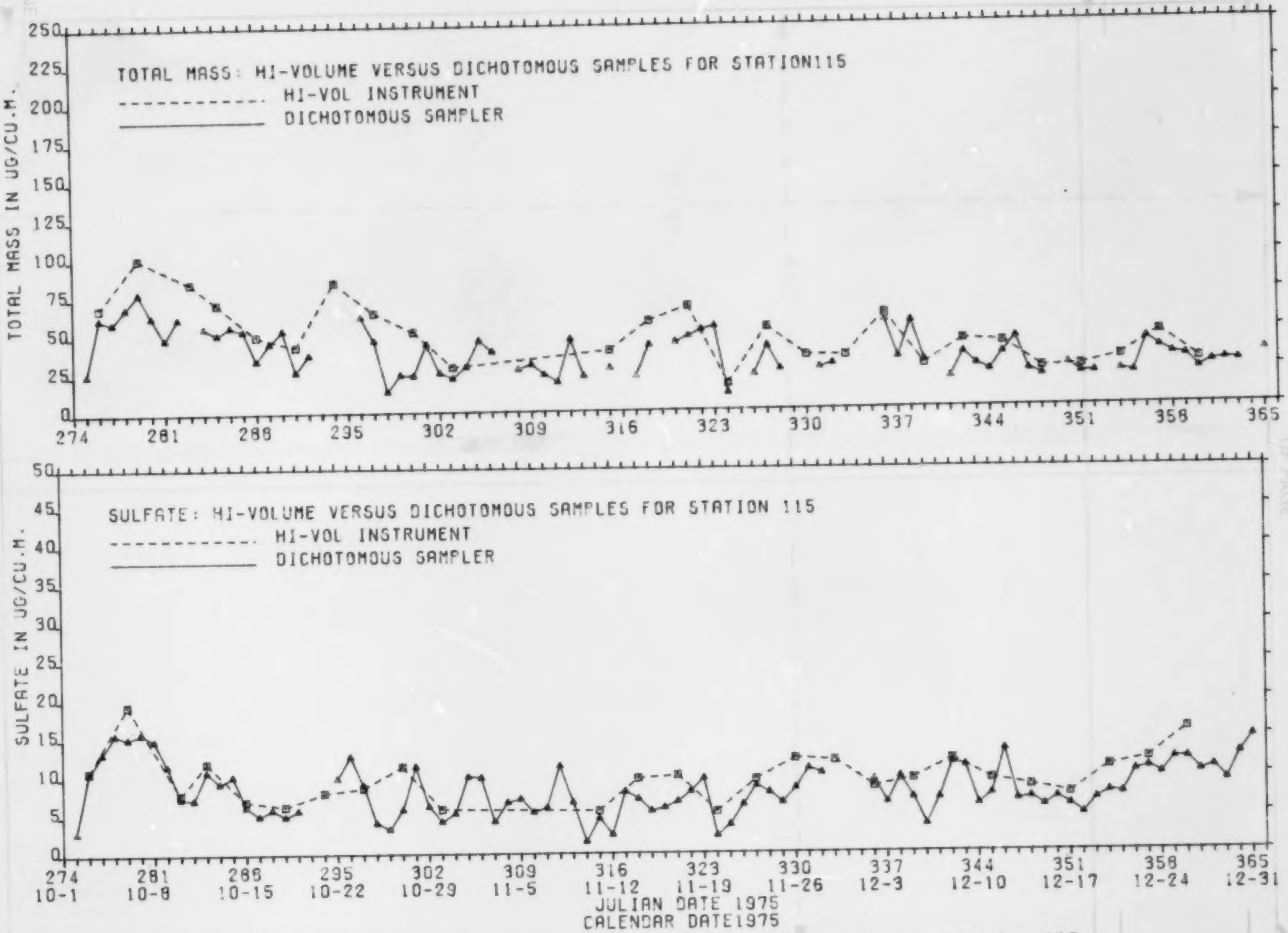

Figure C.43 Comparison of high volume versus dichotomous samples at station 115.

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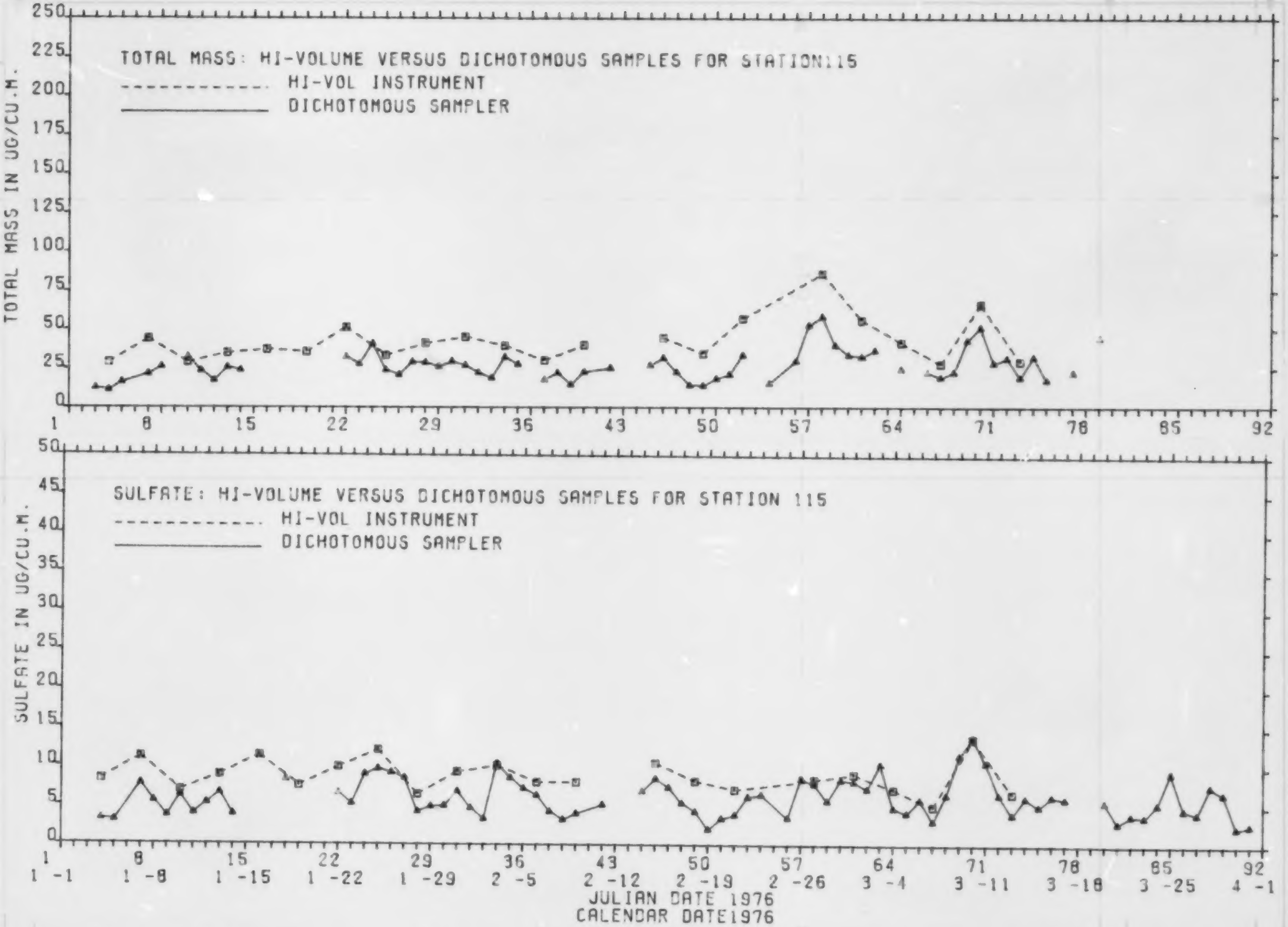

Figure C.44 Comparison of high volume versus dichotomous samples at station 115.

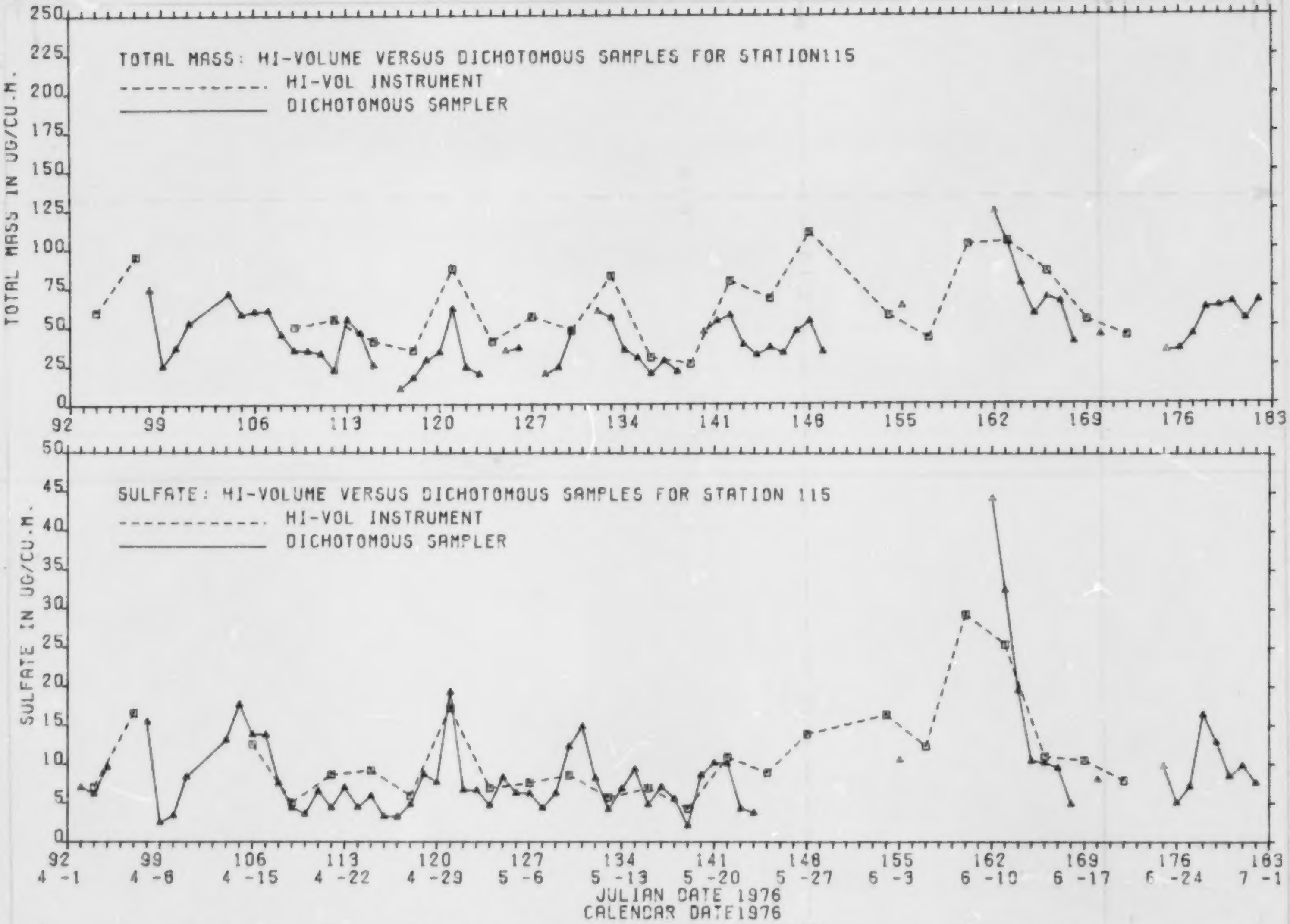

Figure C.45 Comparison of high volume versus dichotomous samples at station 115.

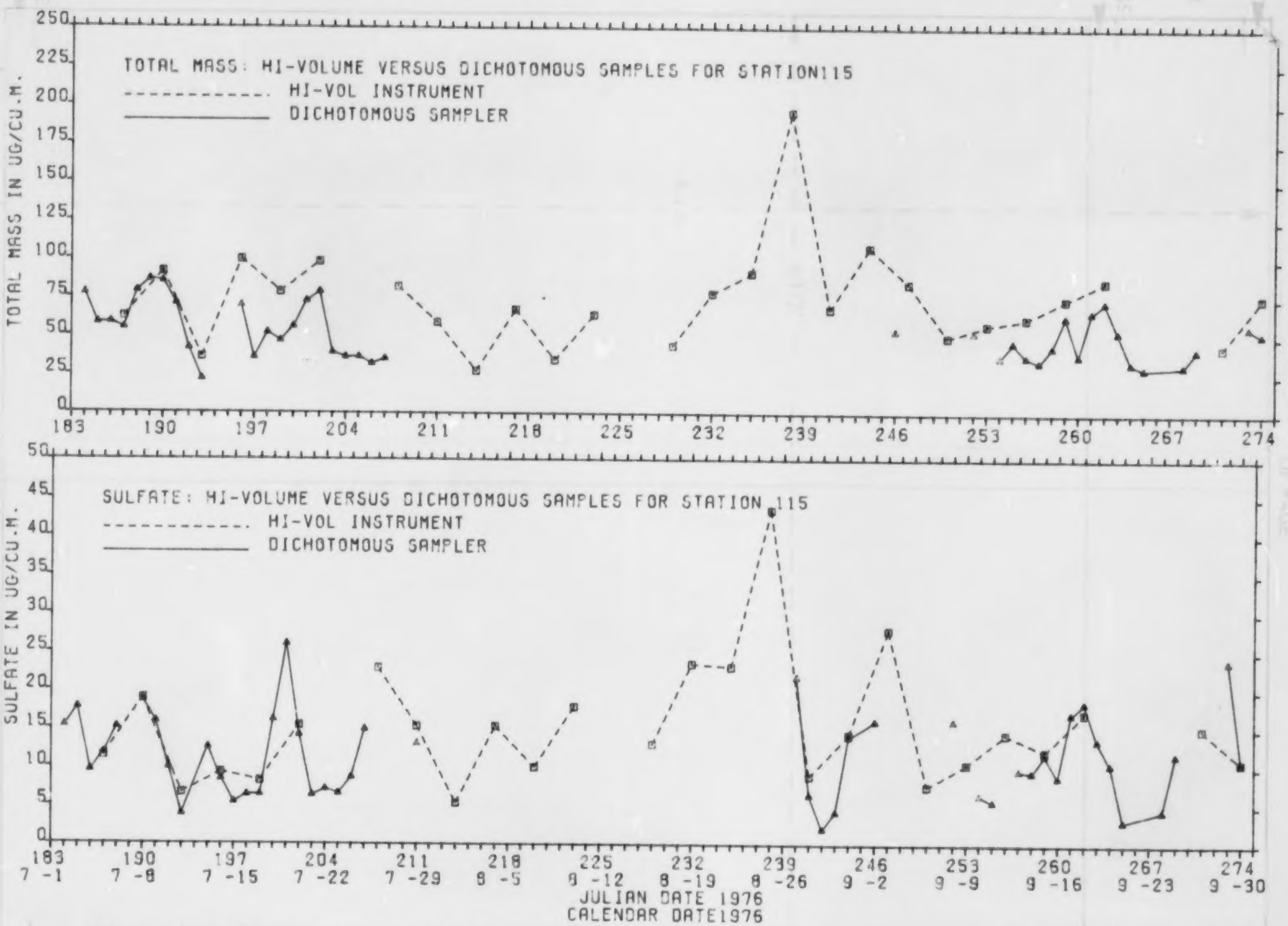

Figure C.46 Comparison of high volume versus dichotomous samples at station 115.

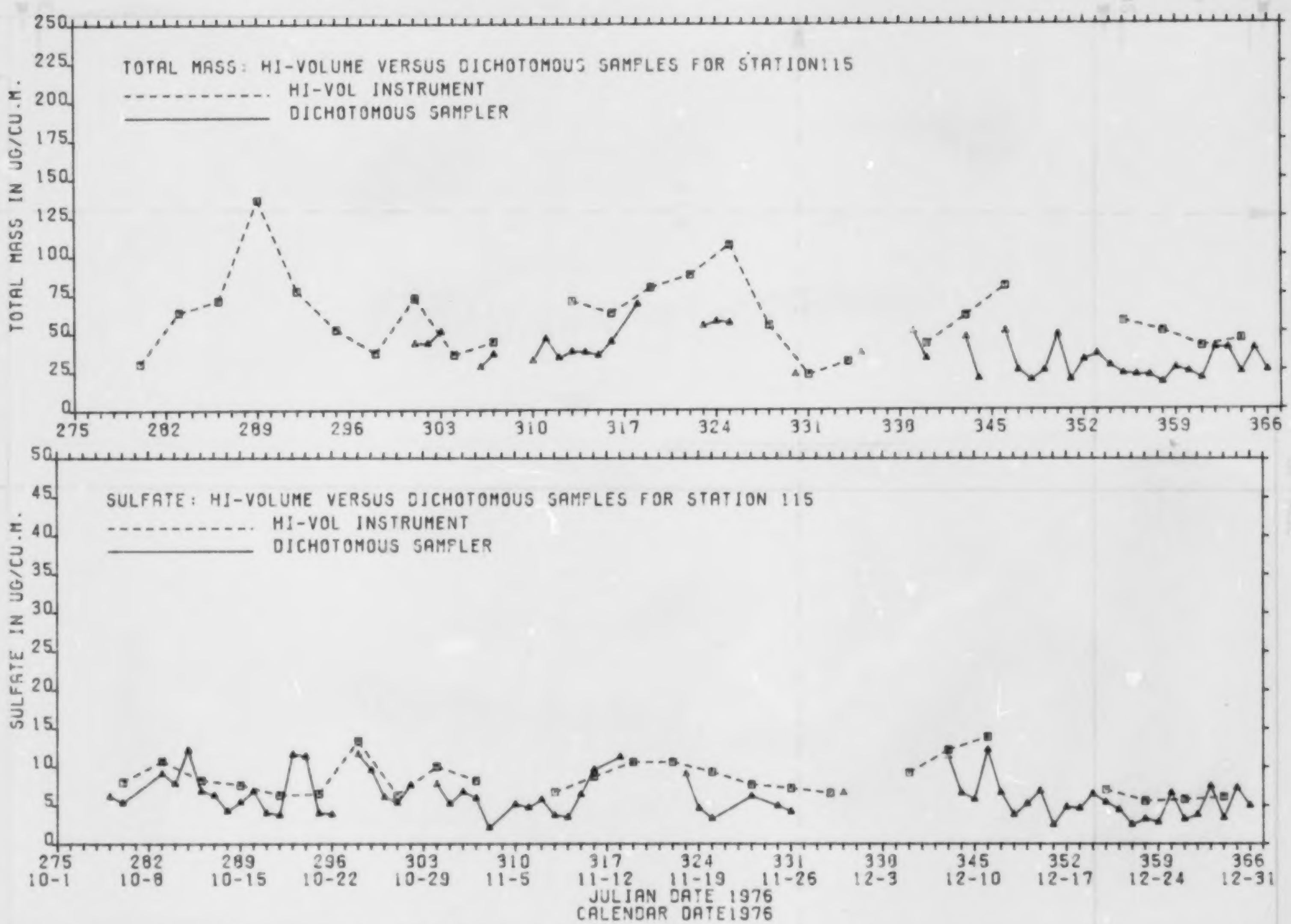

Figure C.47 Comparison of high volume versus dichotomous samples at station 115.

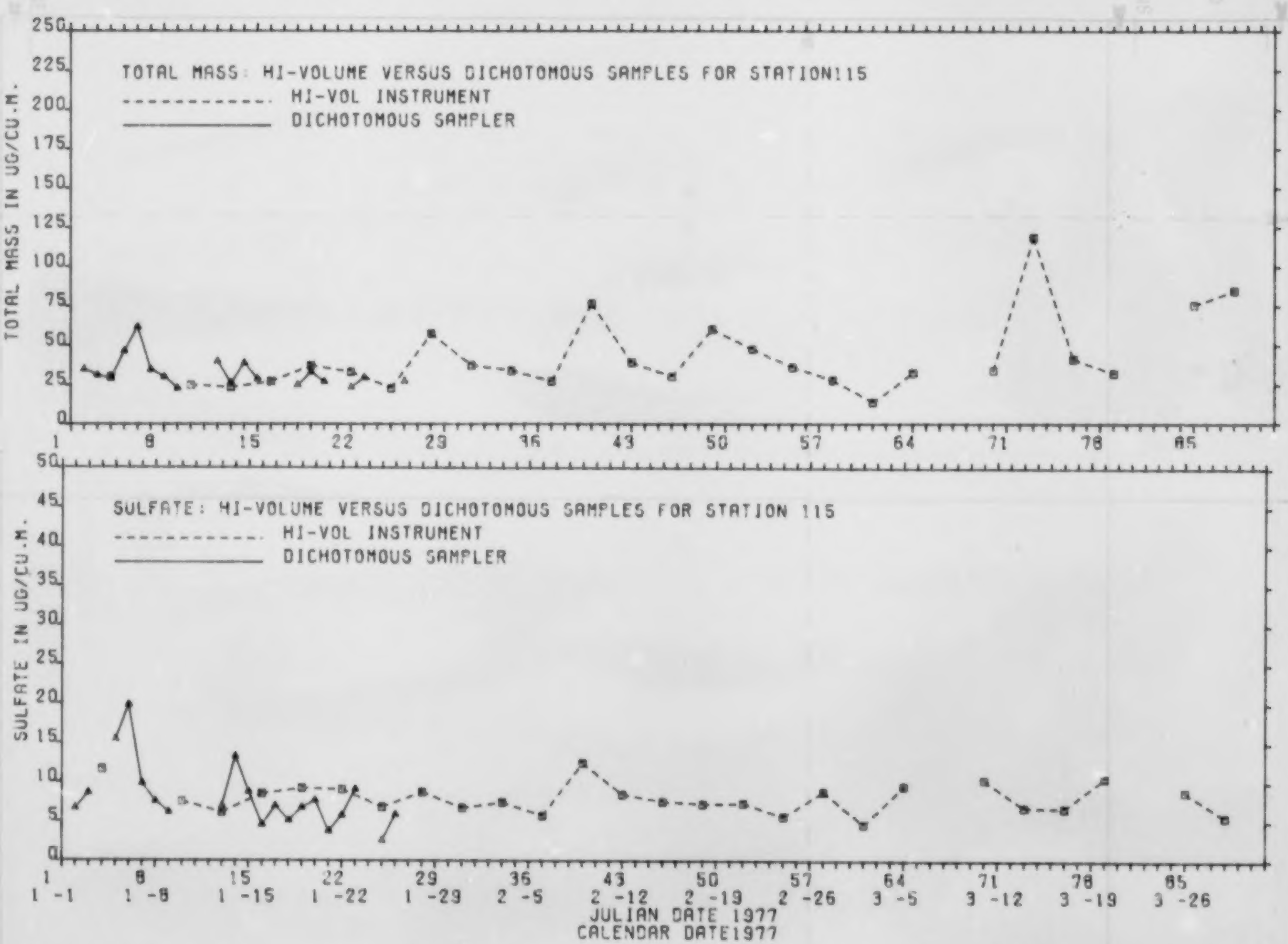

Figure C.48 Comparison of high volume versus dichotomous samples at station 115.

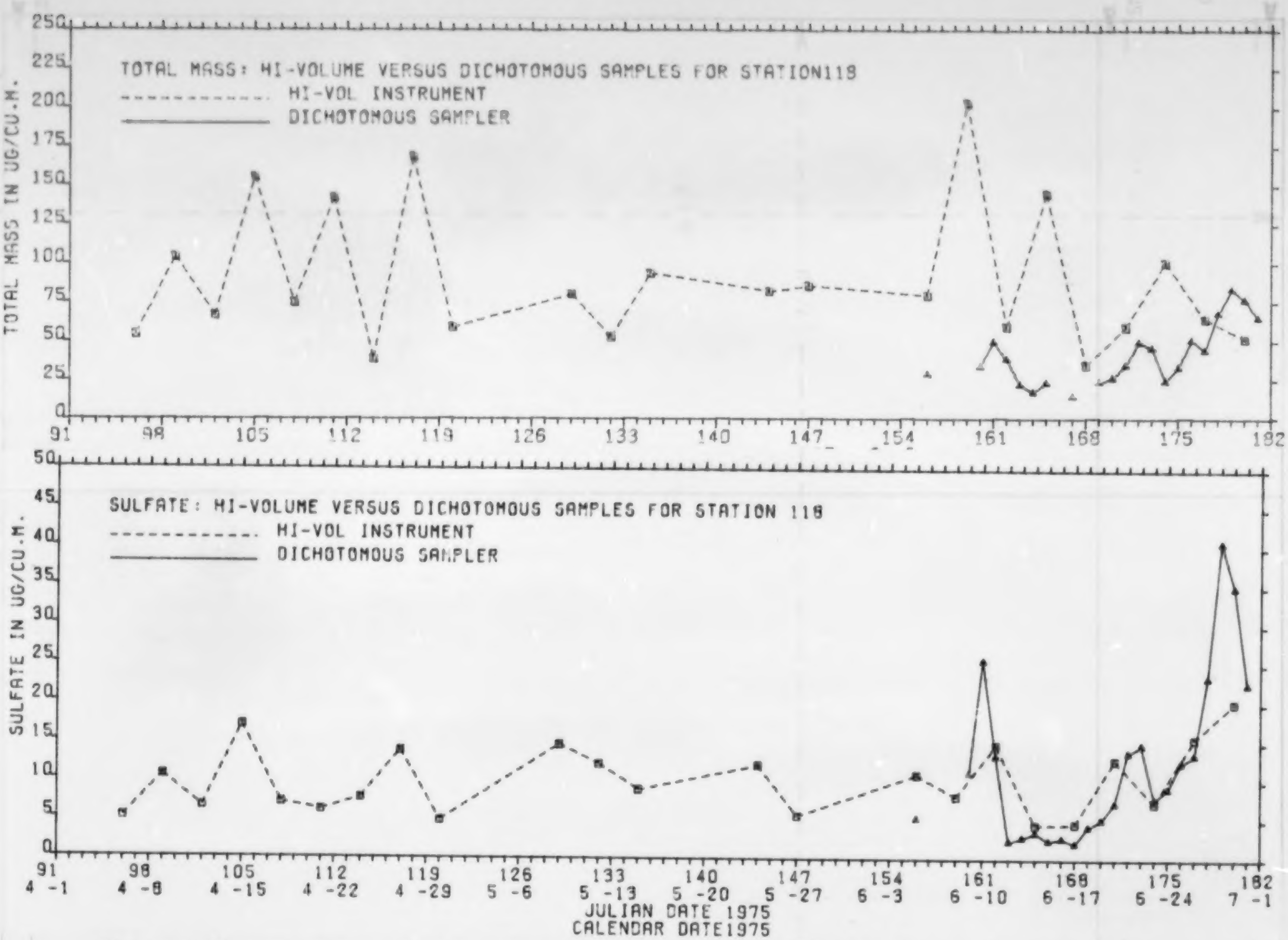

Figure C.49 Comparison of high volume versus dichotomous samples at station 118.

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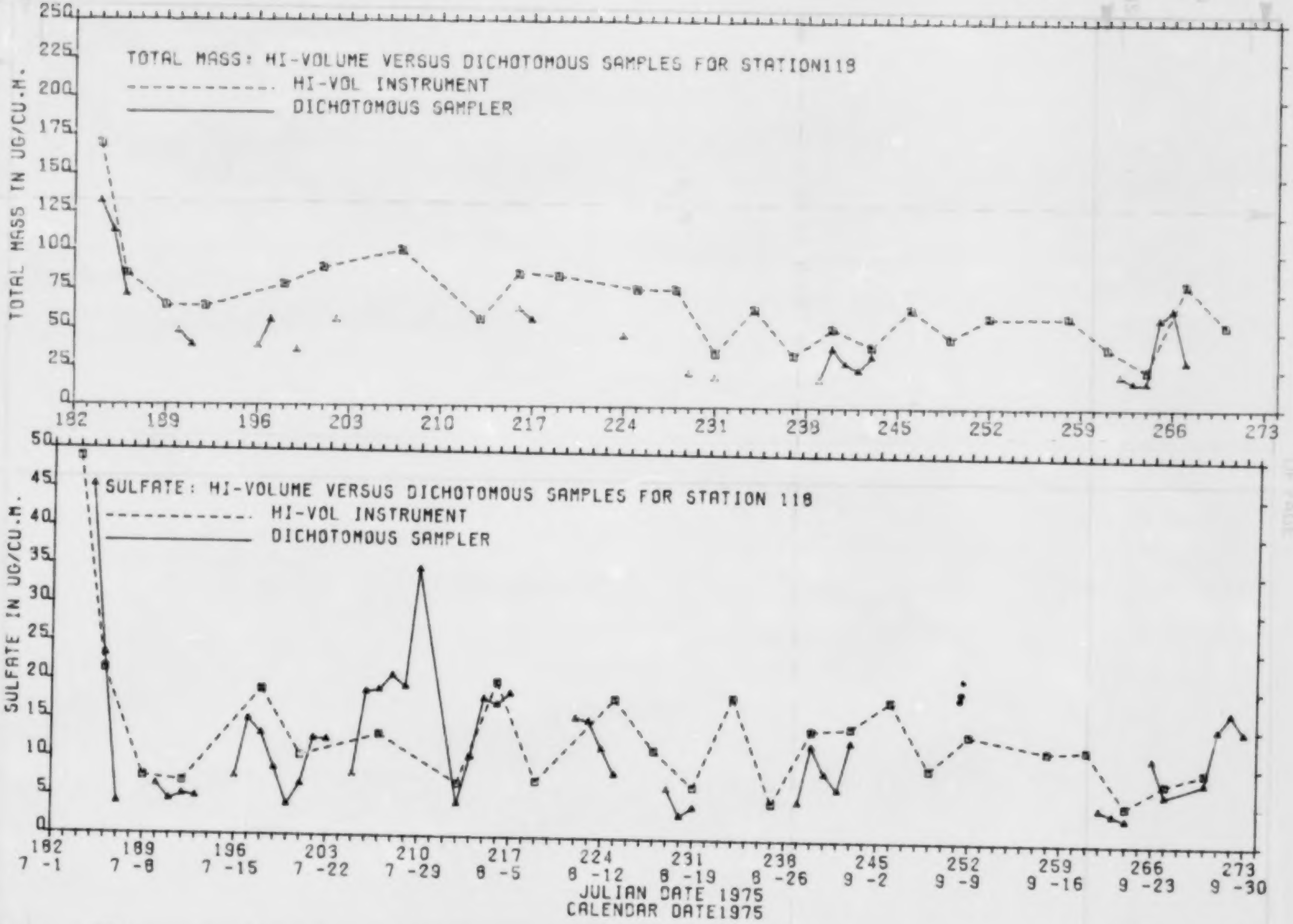

Figure C.50 **Comparison of high volume versus dichotomous samples at station 118.**

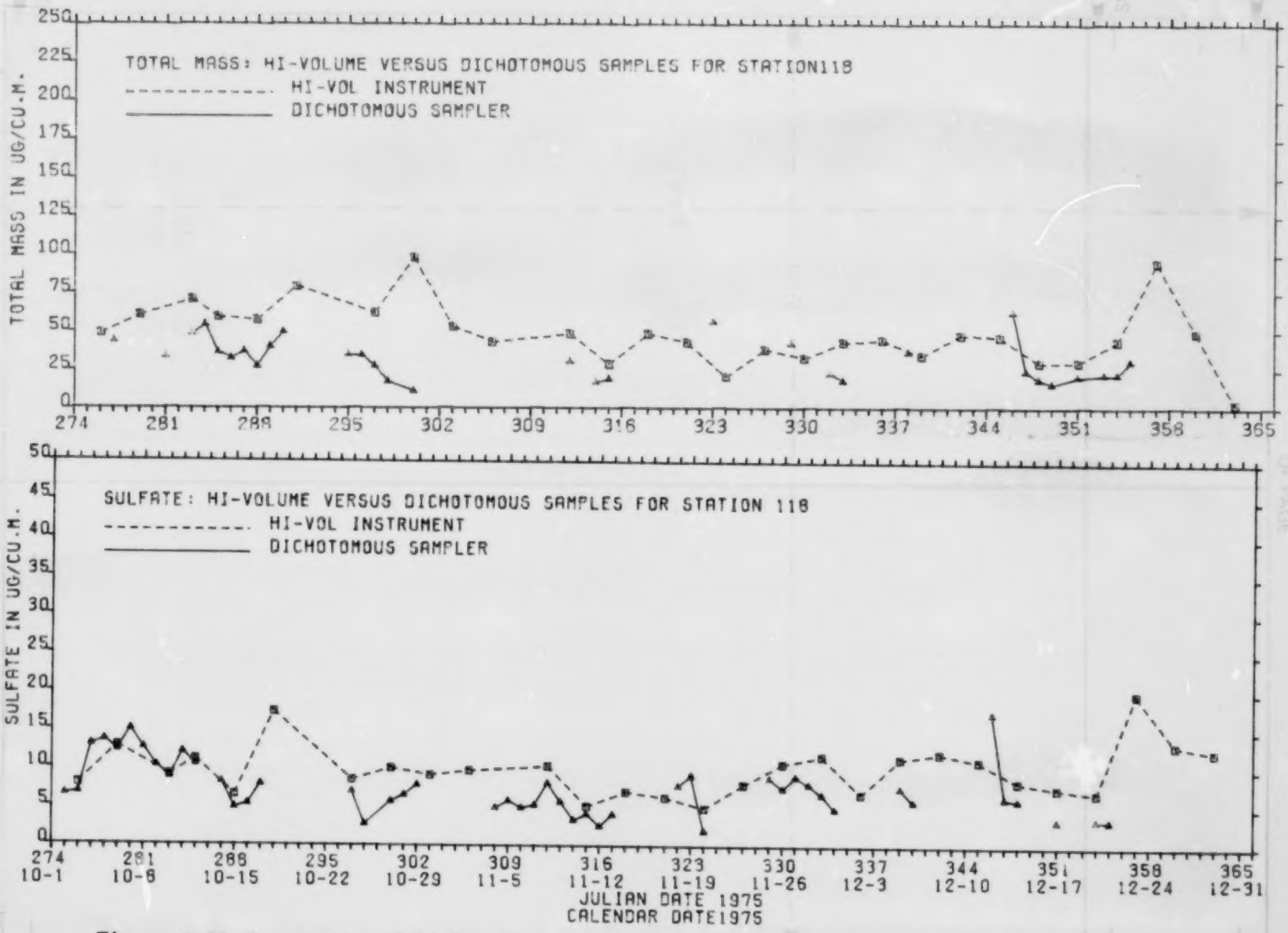

Figure C.51 Comparison of high volume versus dichotomous samples at station 118.

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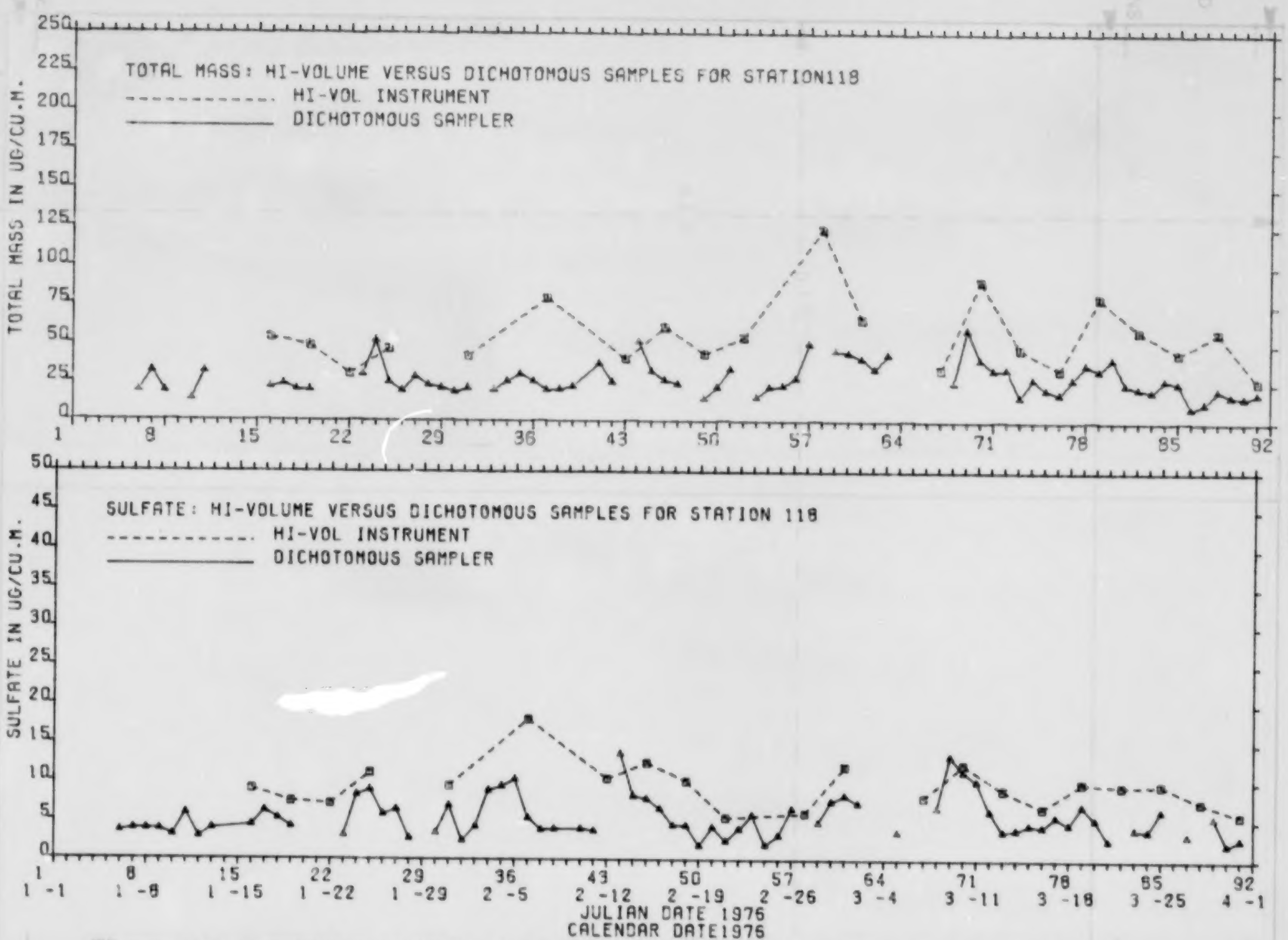

Figure C.52 **Comparison of high volume versus dichotomous samples at station 118.**

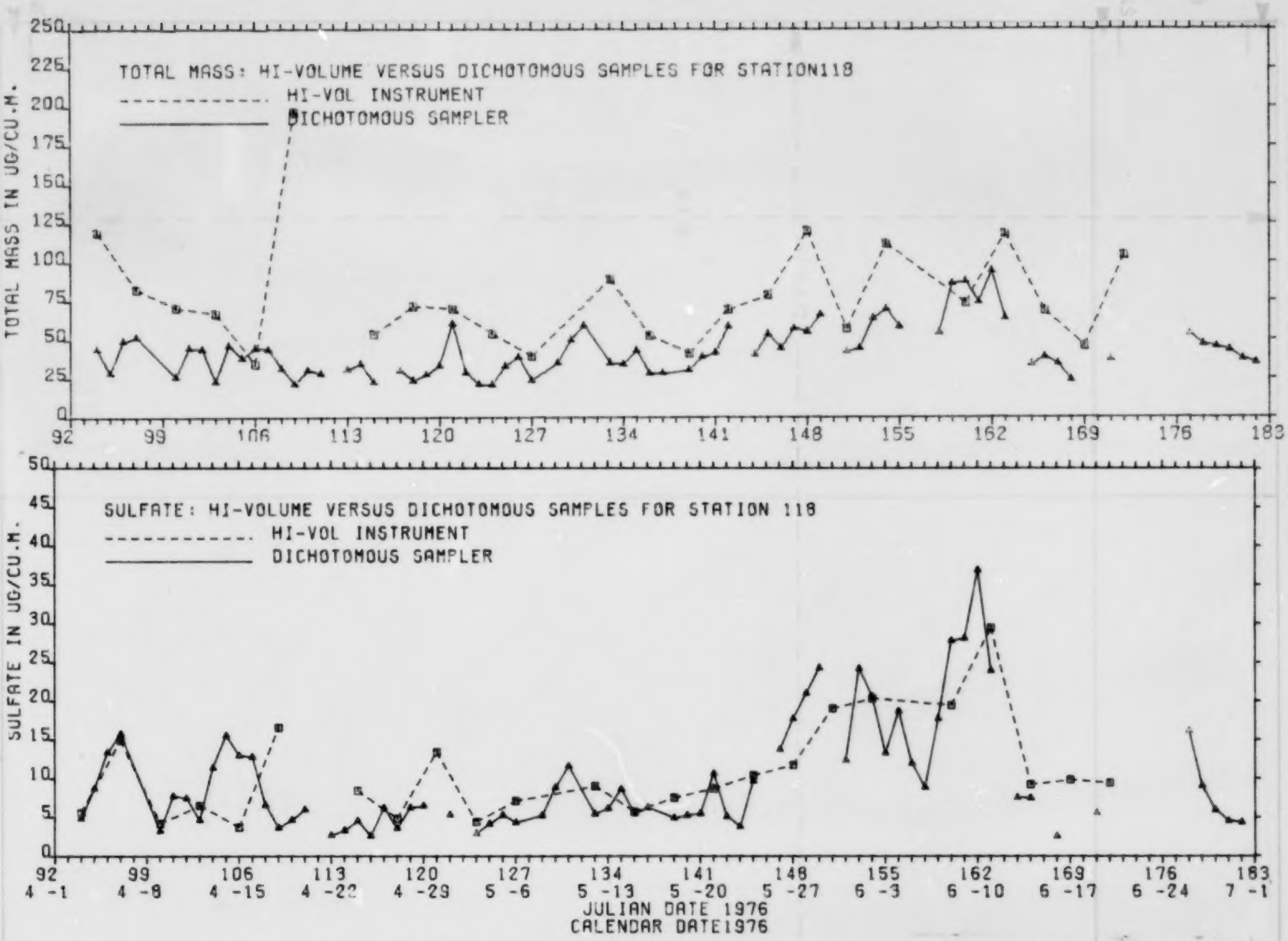

Figure C.53 Comparison of high volume versus dichotomous samples at station 118.

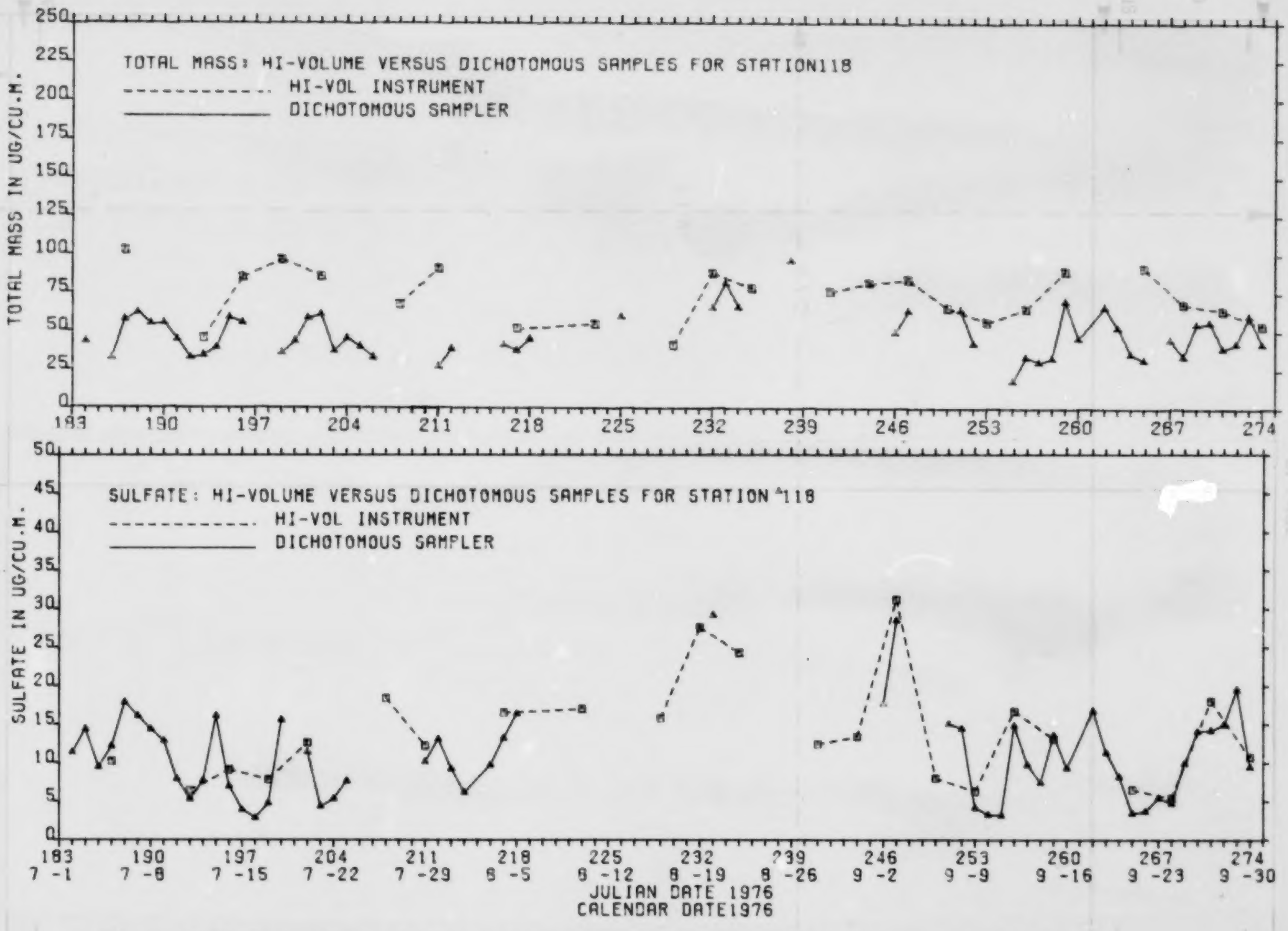

Figure C.54 Comparison of high volume versus dichotomous samples at station 118.

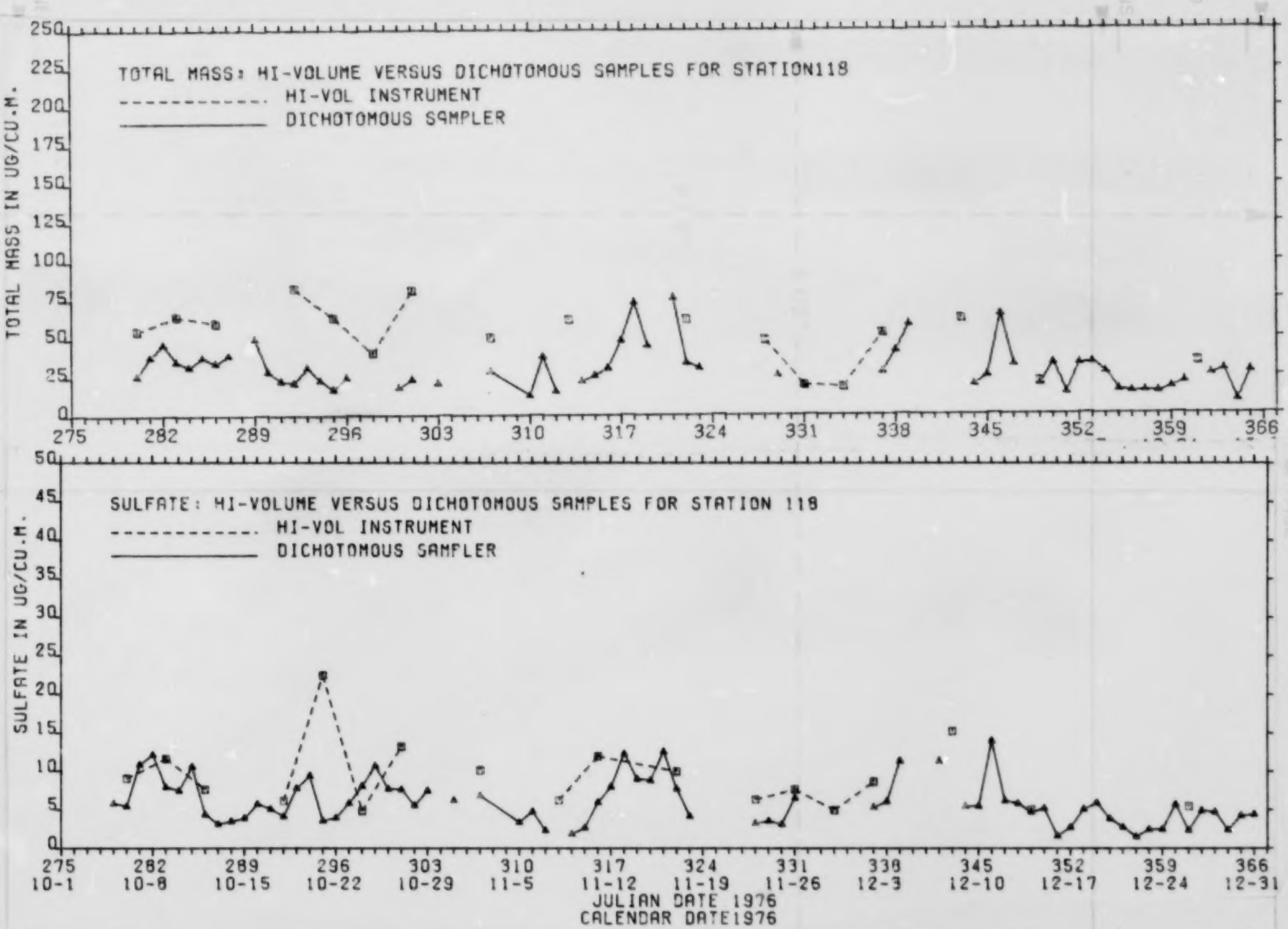

Figure C.55 **Comparison of high volume versus dichotomous samples at station 118.**

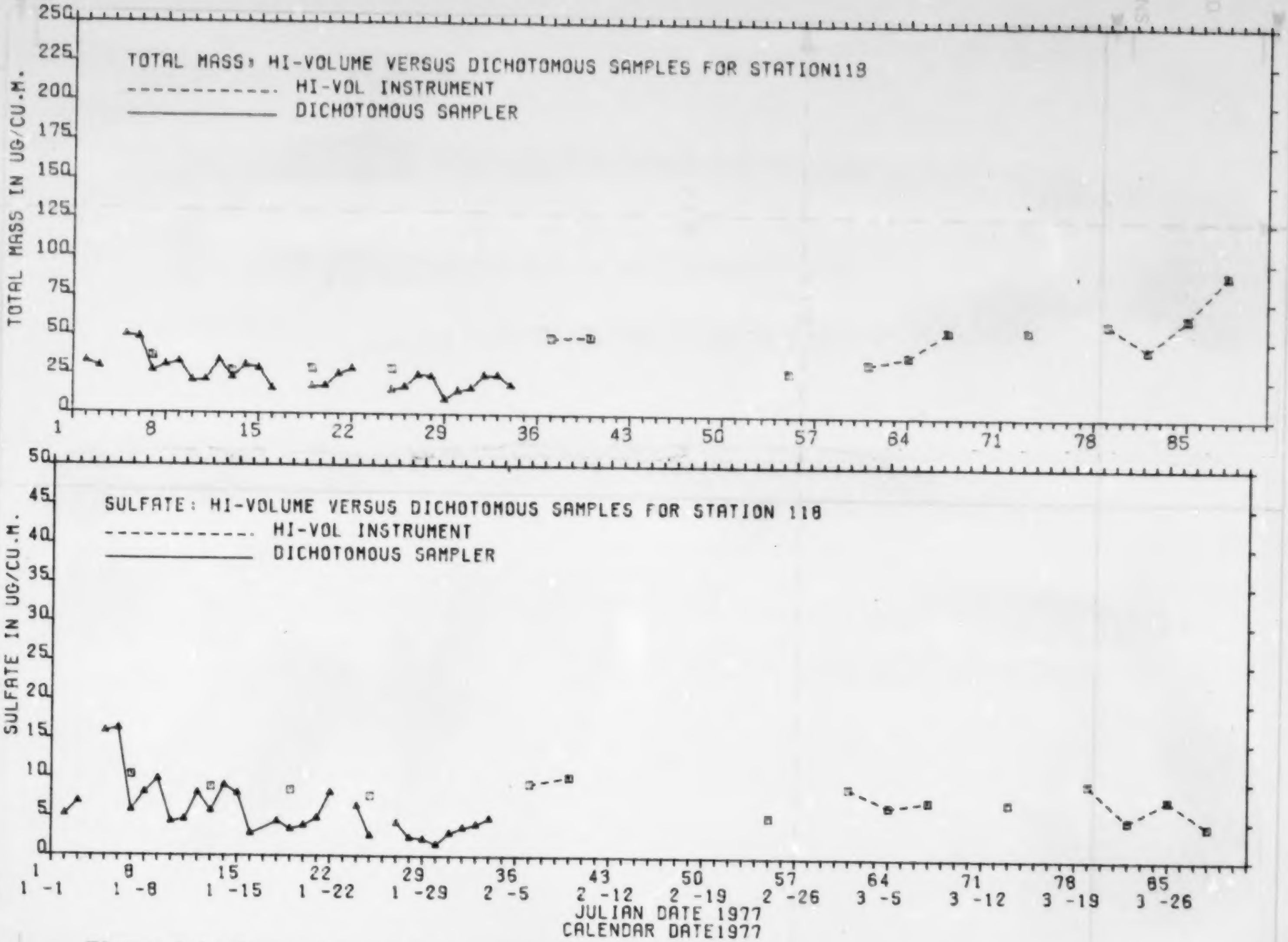

Figure C.56 Comparison of high volume versus dichotomous samples at station 118.

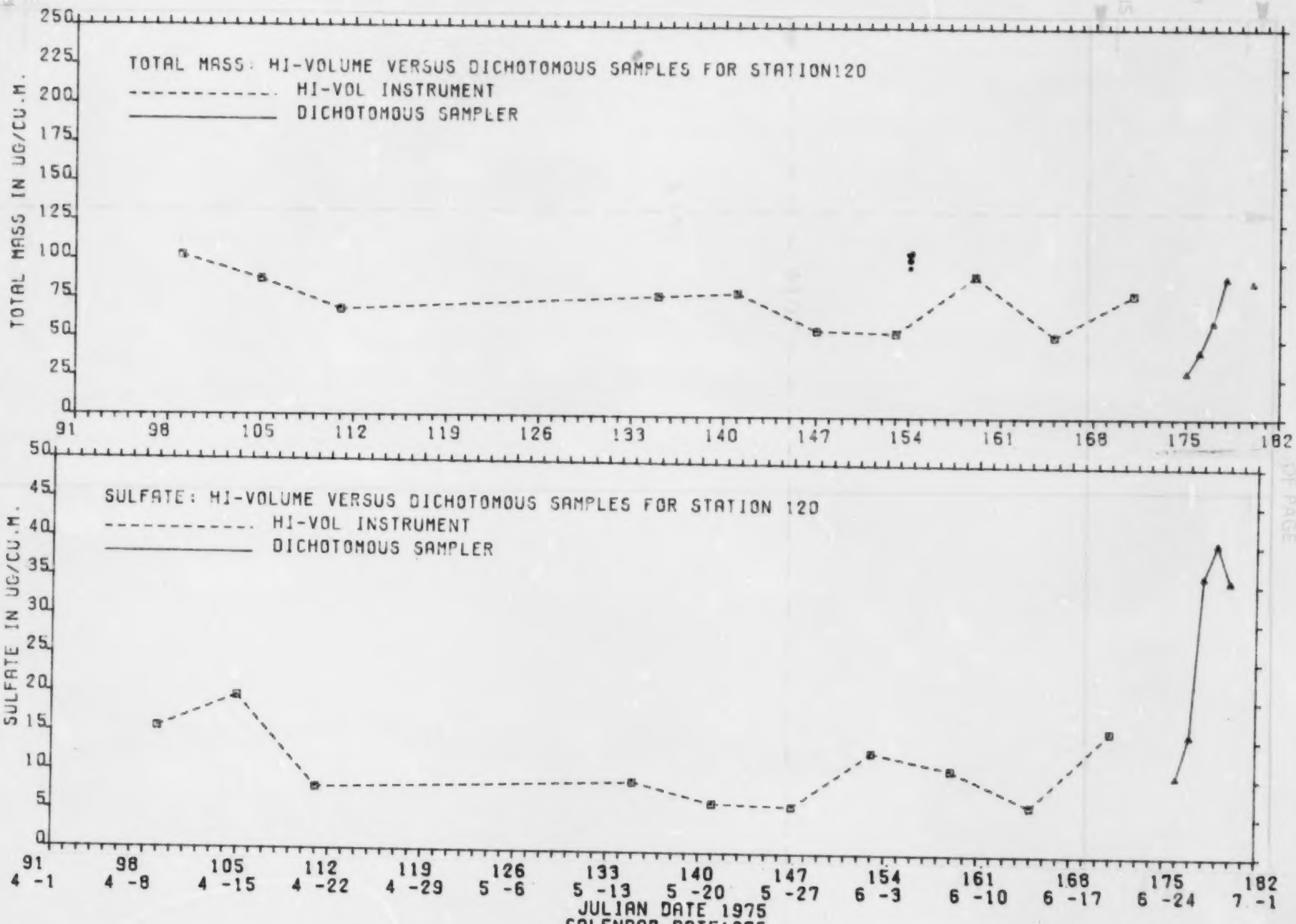

Figure C.57 Comparison of high volume versus dichotomous samples at station 120.

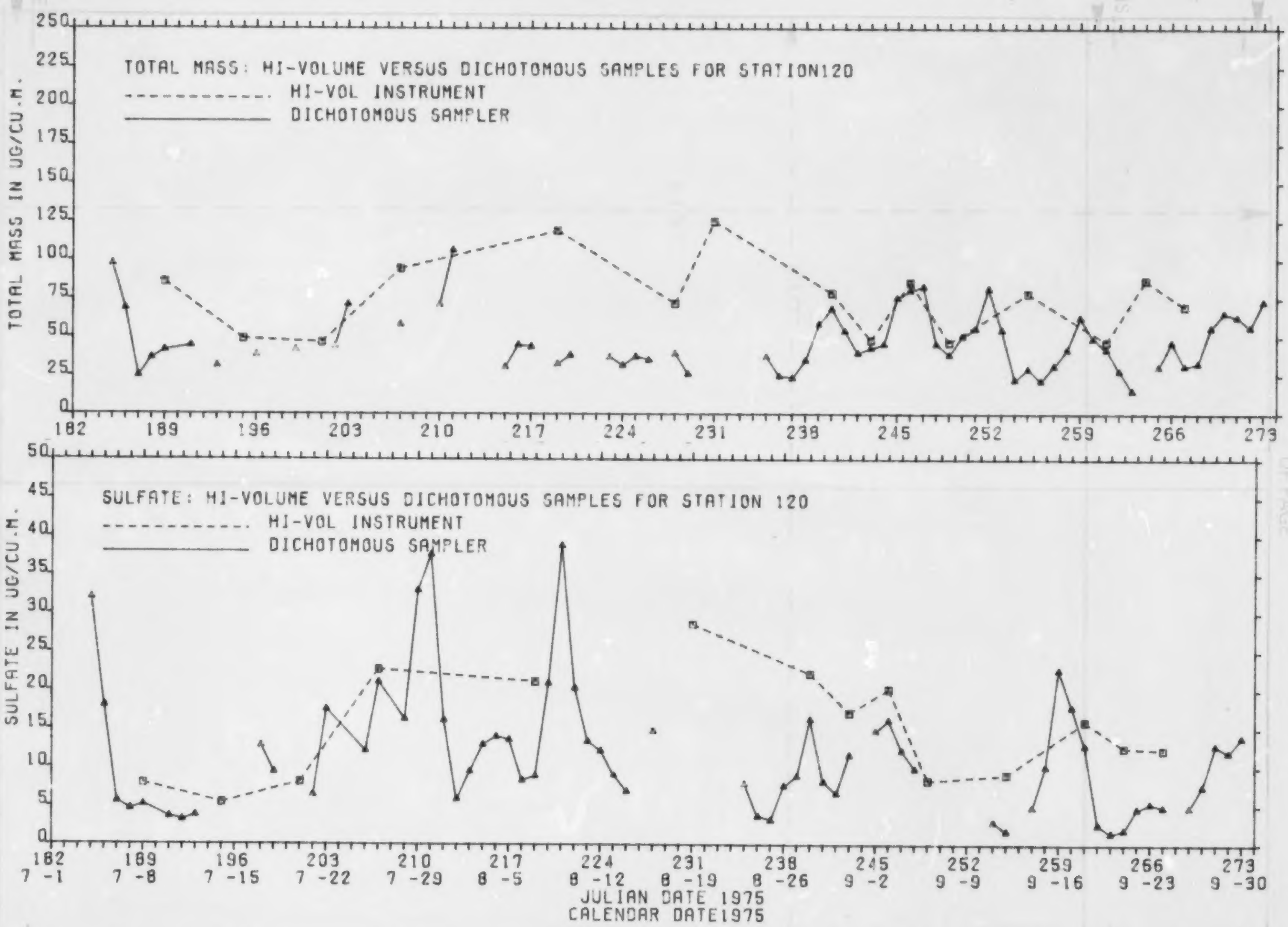

Figure C.58 Comparison of high volume versus dichotomous samples at station 120.

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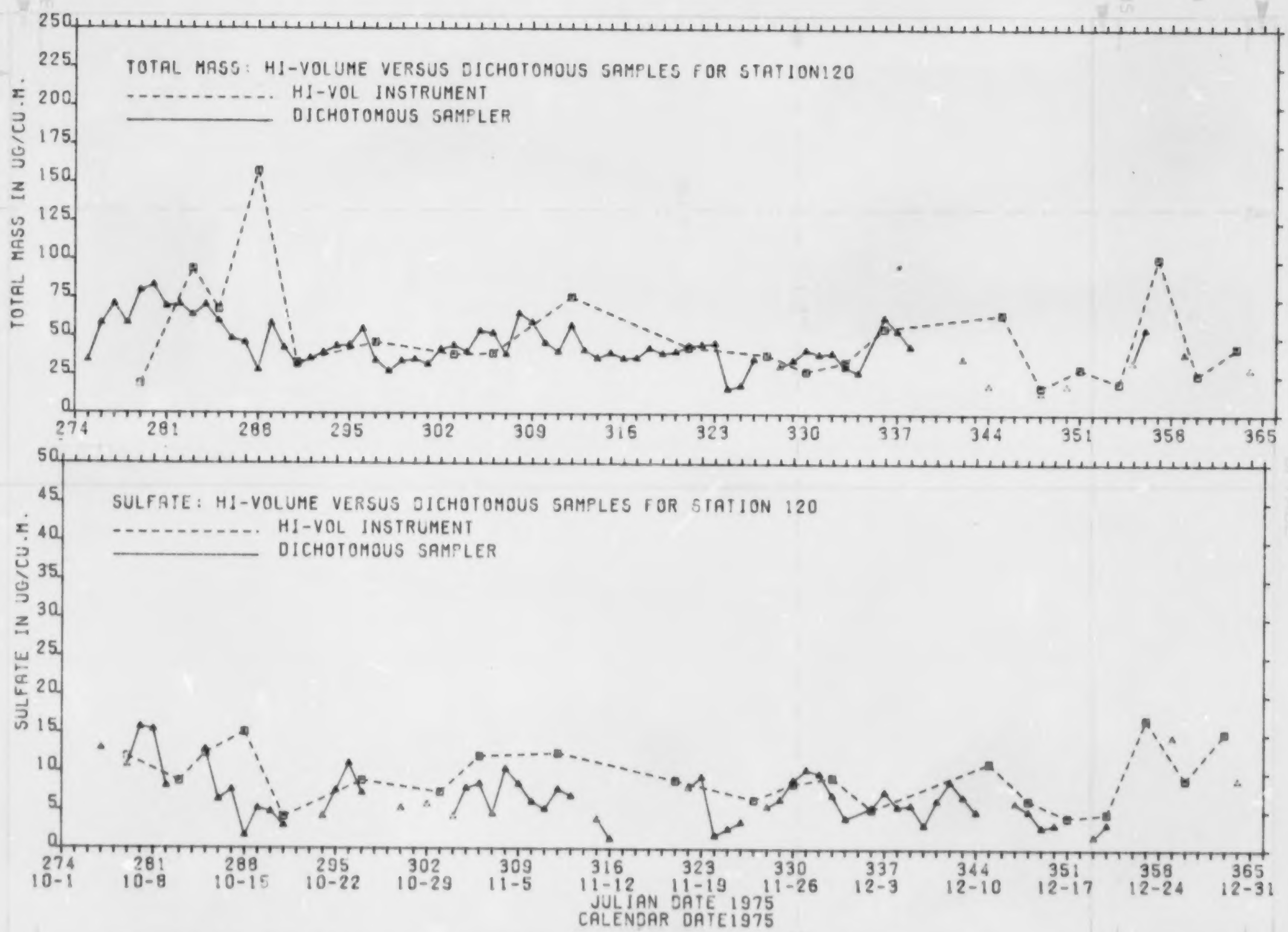

Figure C.59 Comparison of high volume versus dichotomous samples at station 120.

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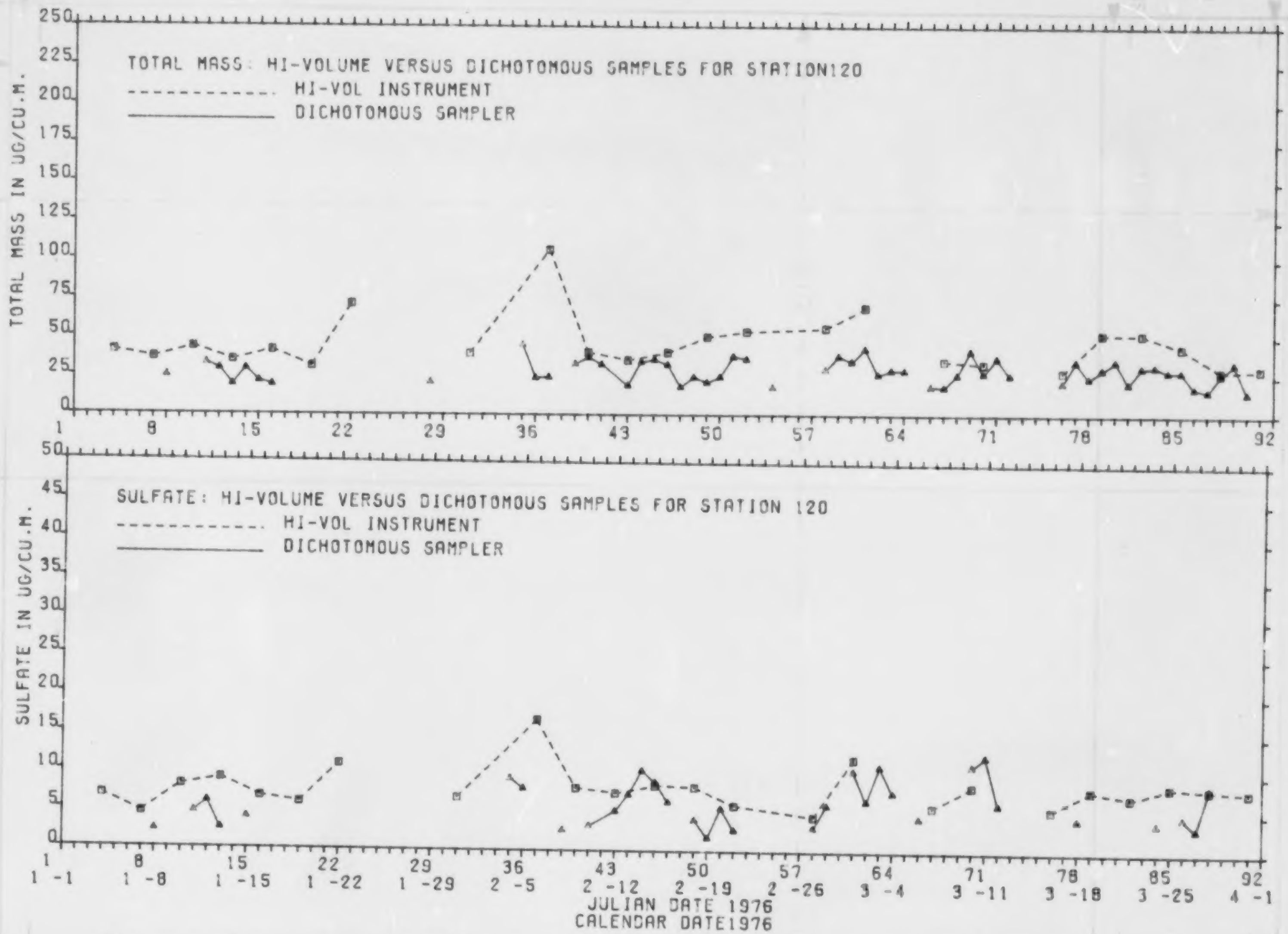

Figure C.60 Comparison of high volume versus dichotomous samples at station 120.

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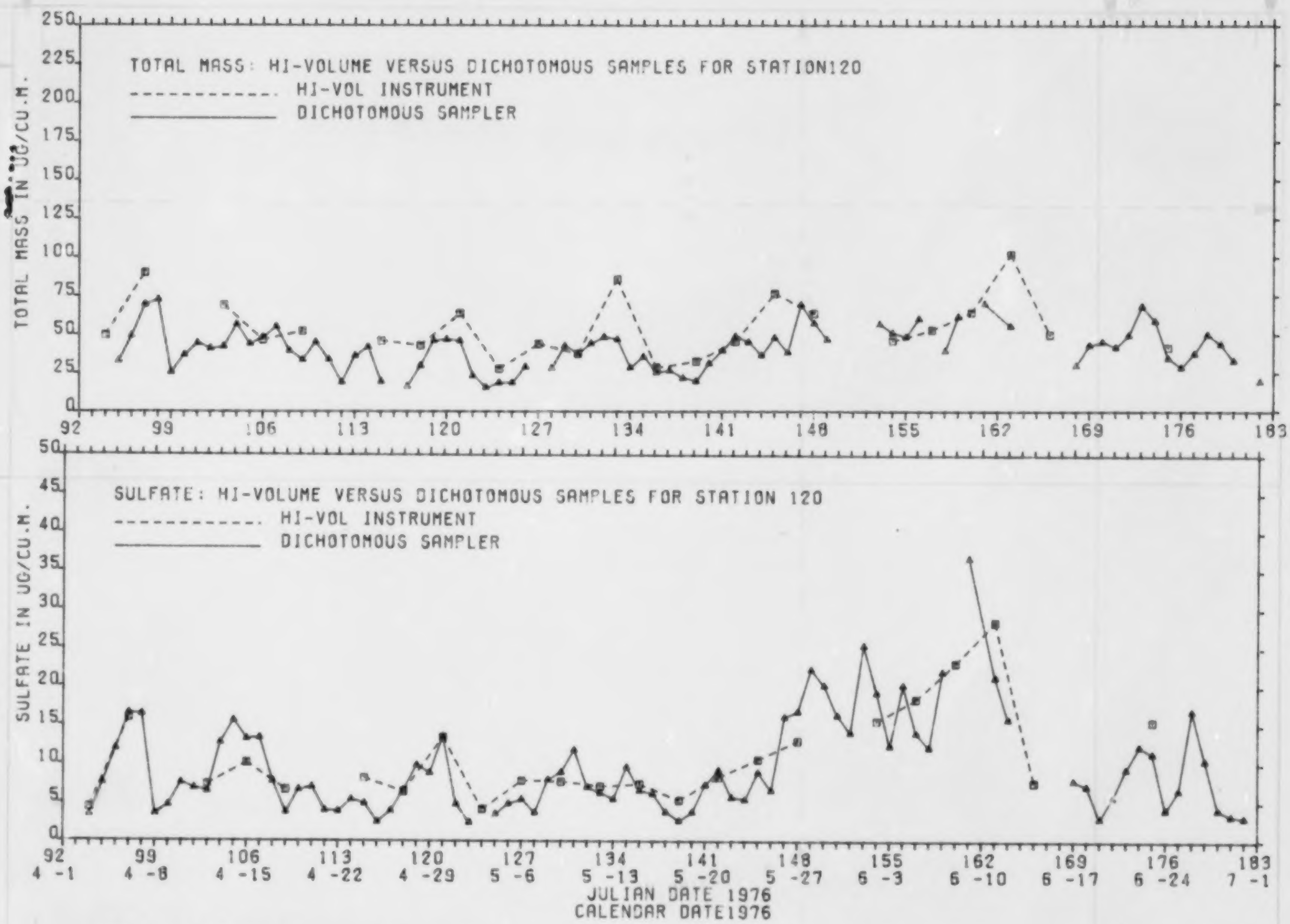

Figure C.61 Comparison of high volume versus dichotomous samples at station 120.

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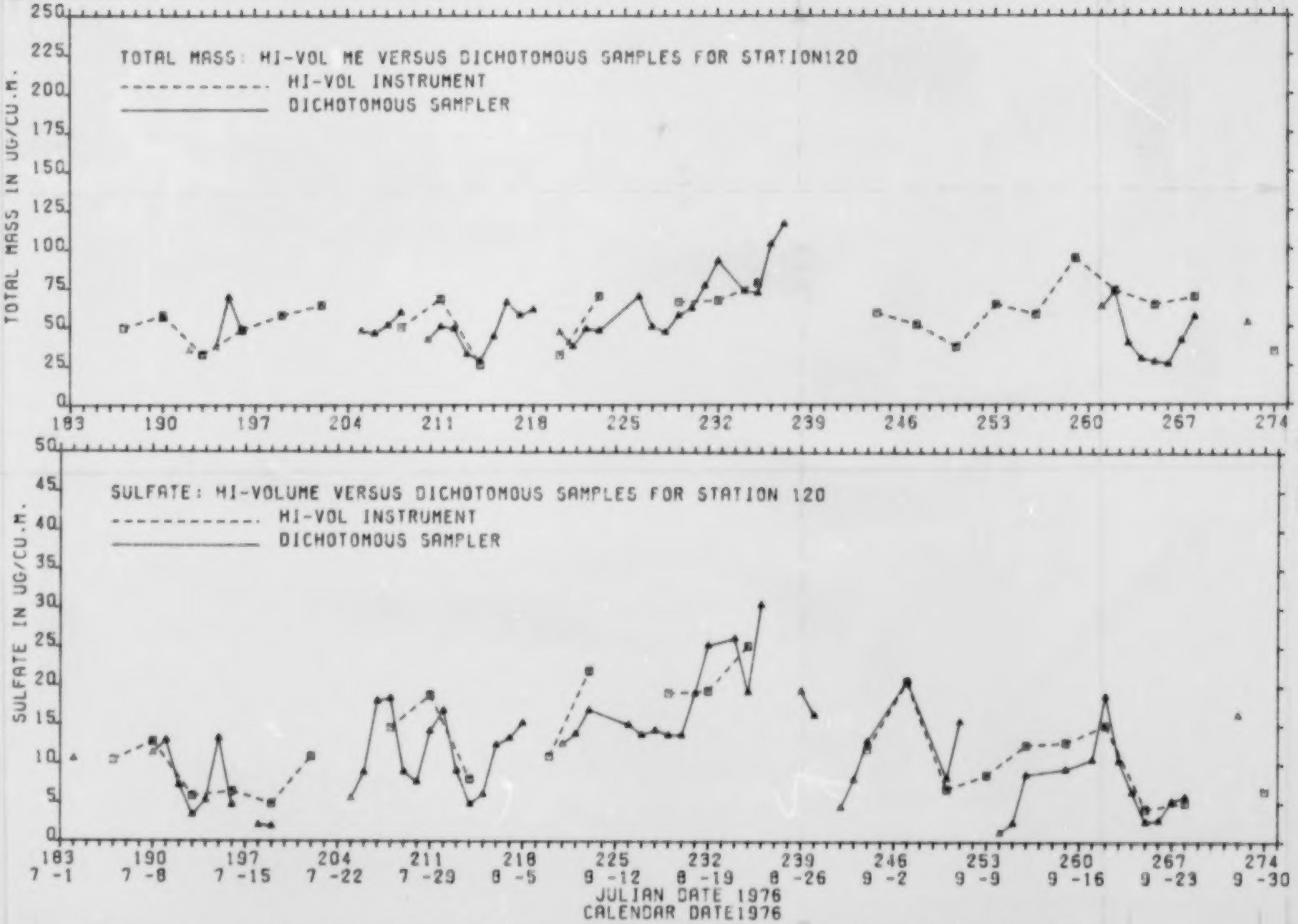

Figure C.62 Comparison of high volume versus dichotomous samples at station 120.

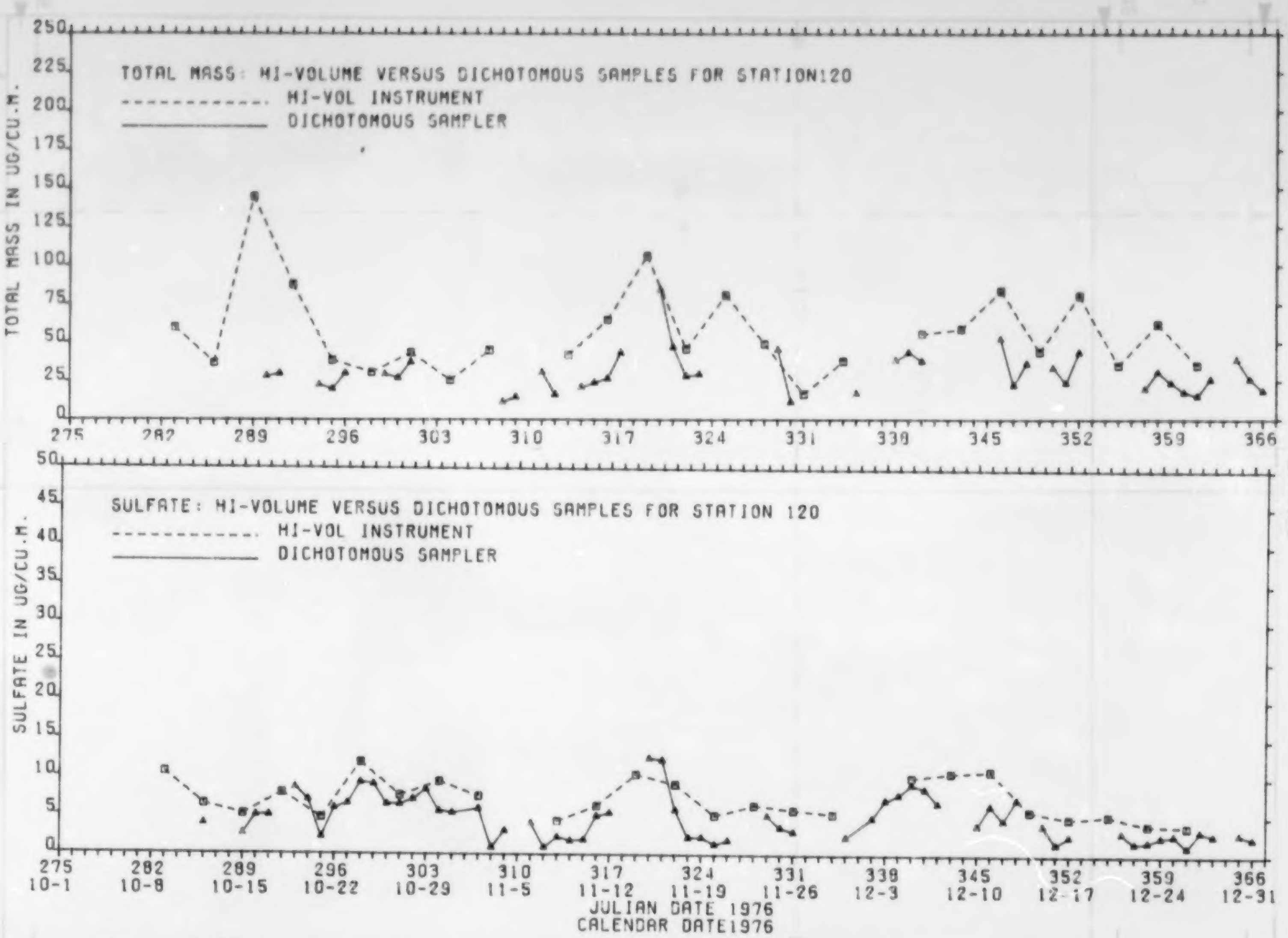

Figure C.63 Comparison of high volume versus dichotomous samples at station 120.

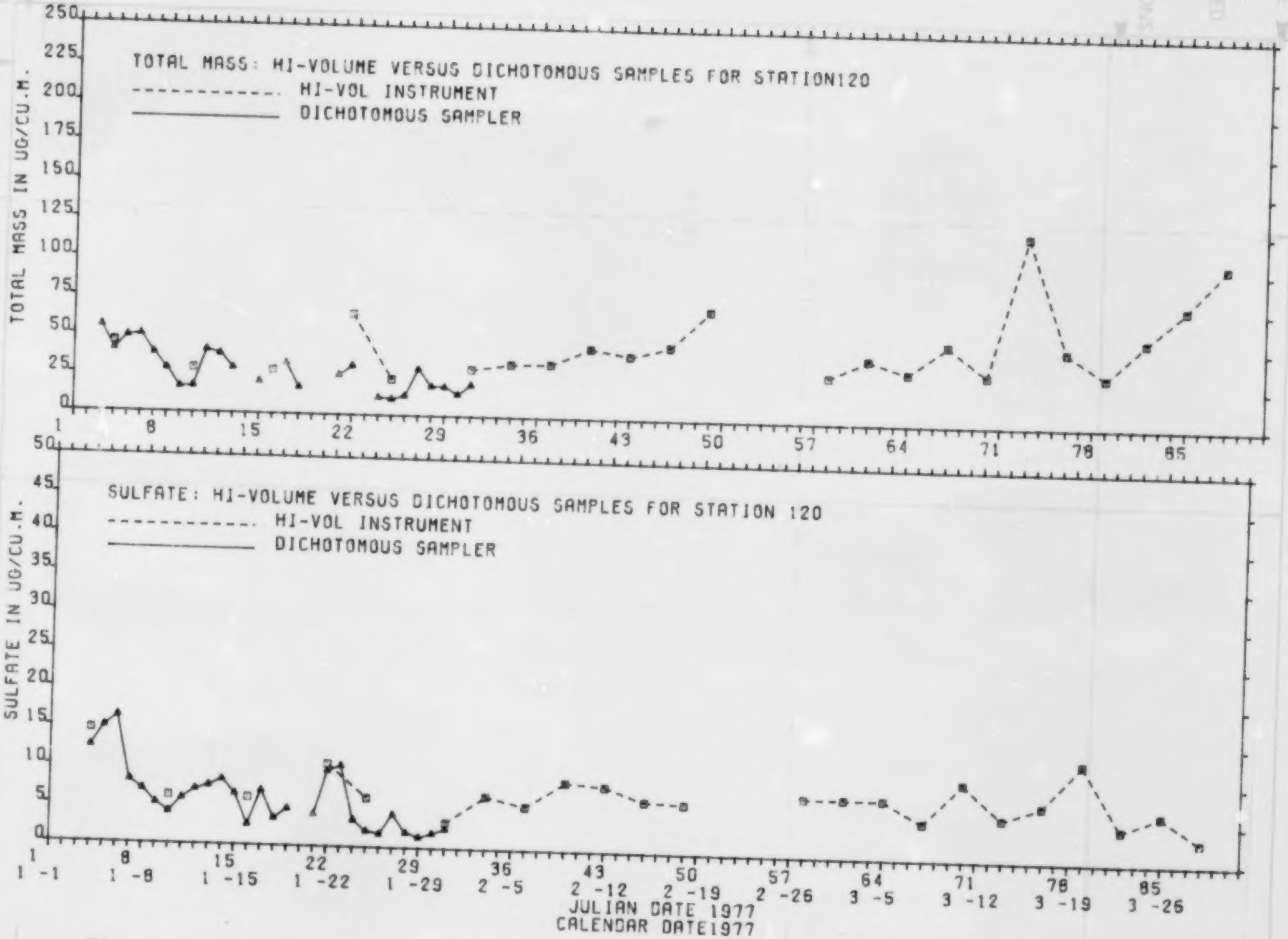

Figure C.64 Comparison of high volume versus dichotomous samples at station 120.

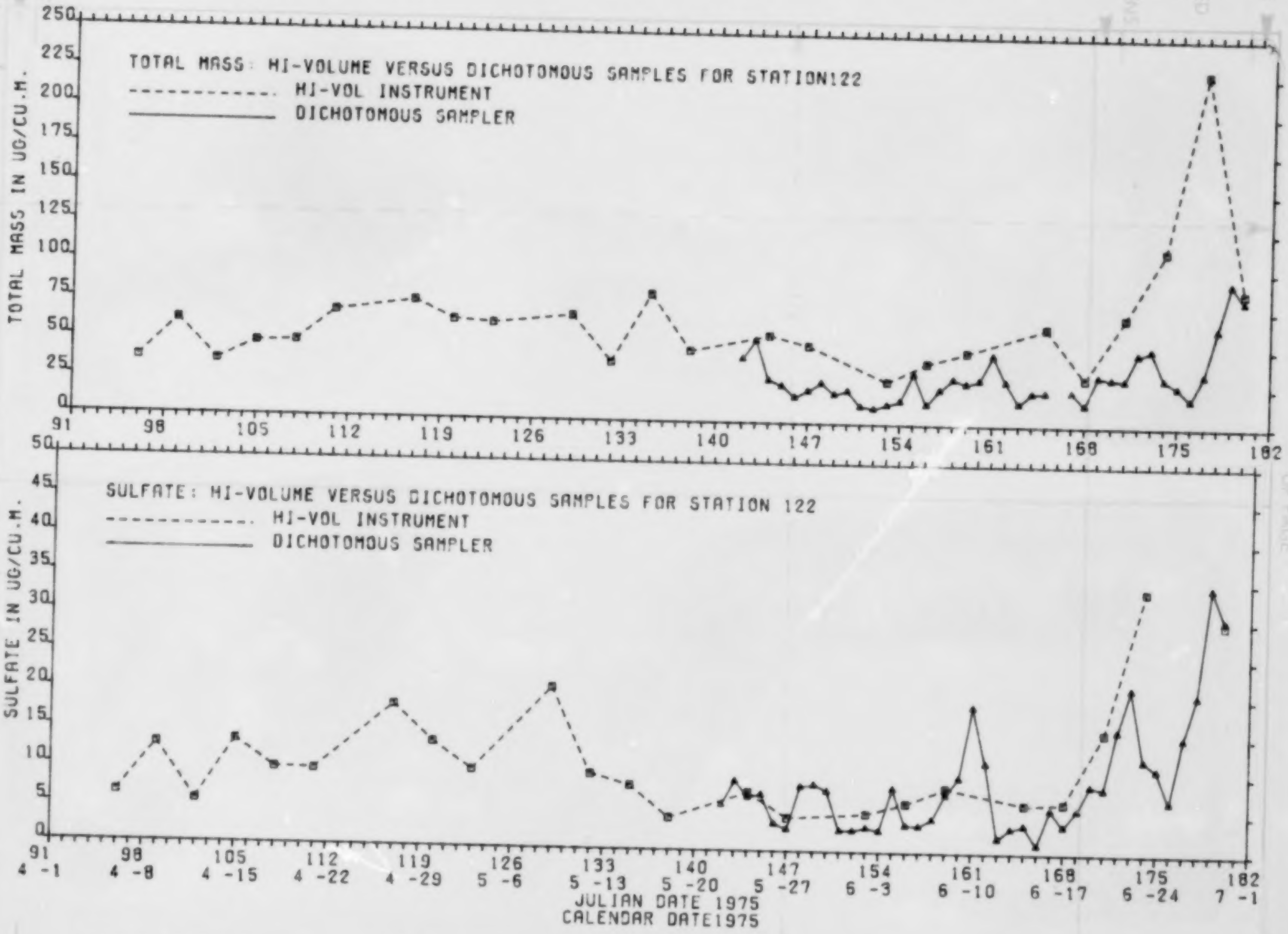

Figure C.65 Comparison of high volume versus dichotomous samples at station 122.

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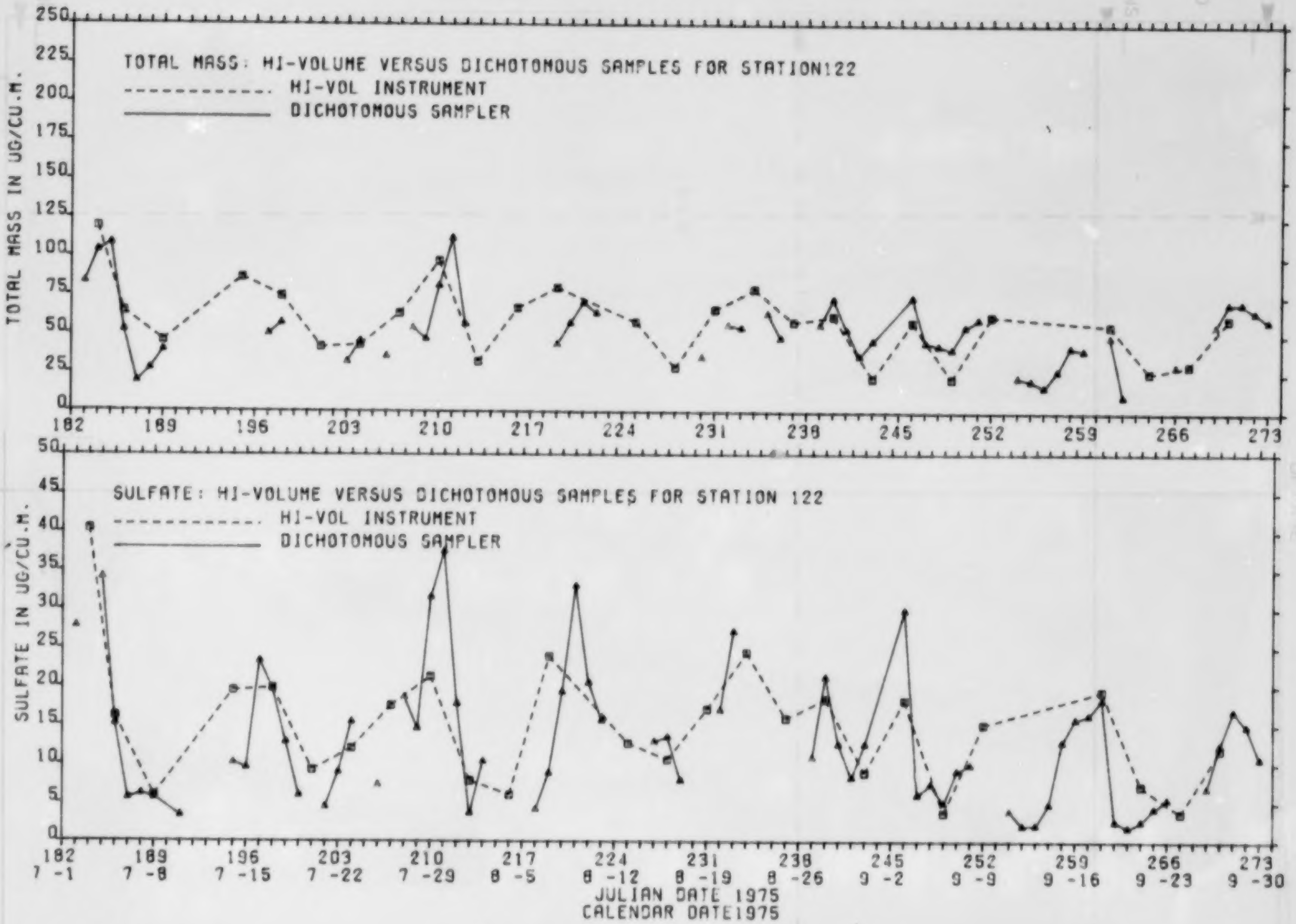

Figure C.66 Comparison of high volume versus dichotomous samples at station 122.

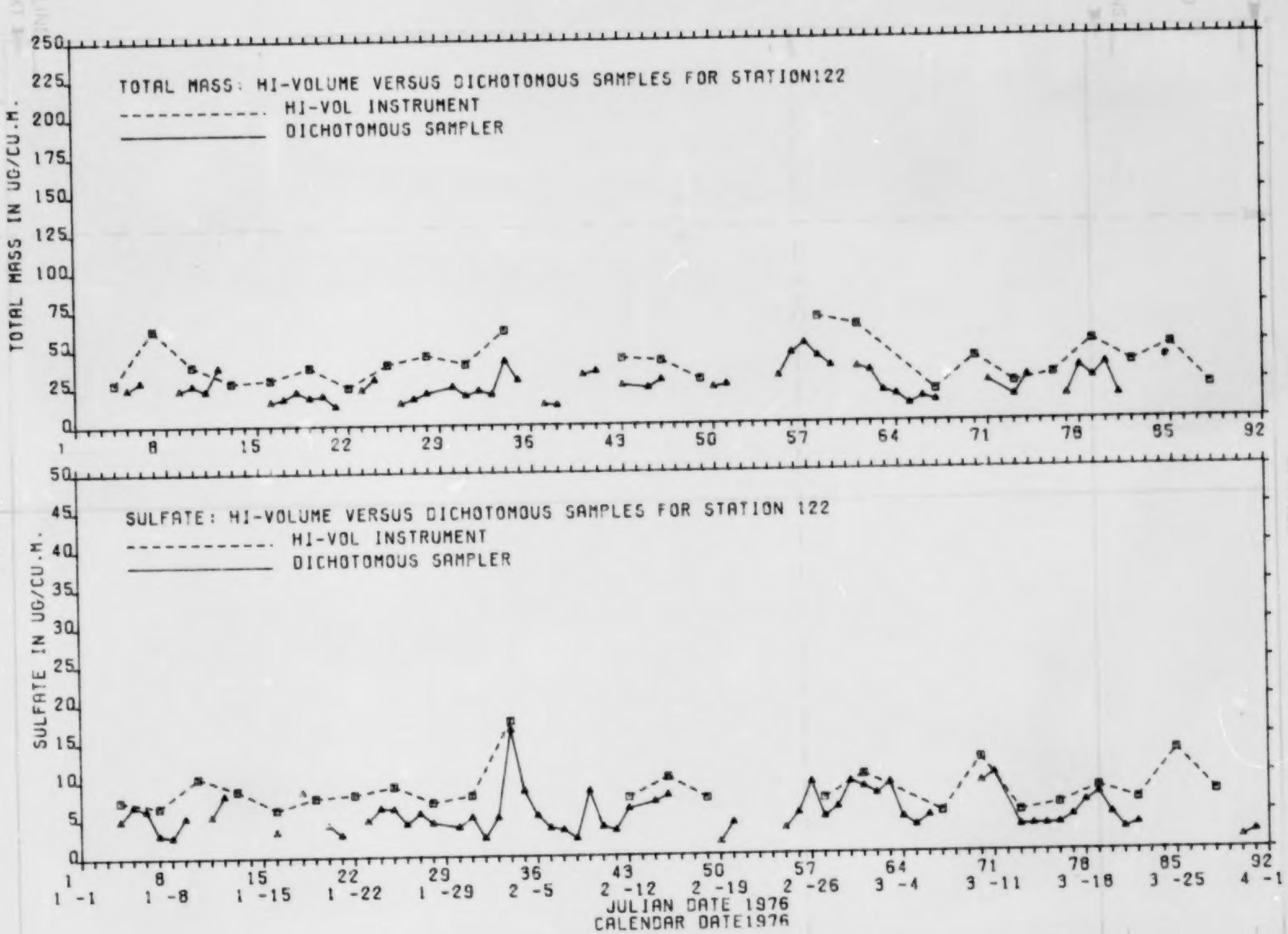

Figure C.67 Comparison of high volume versus dichotomous samples at station 122.

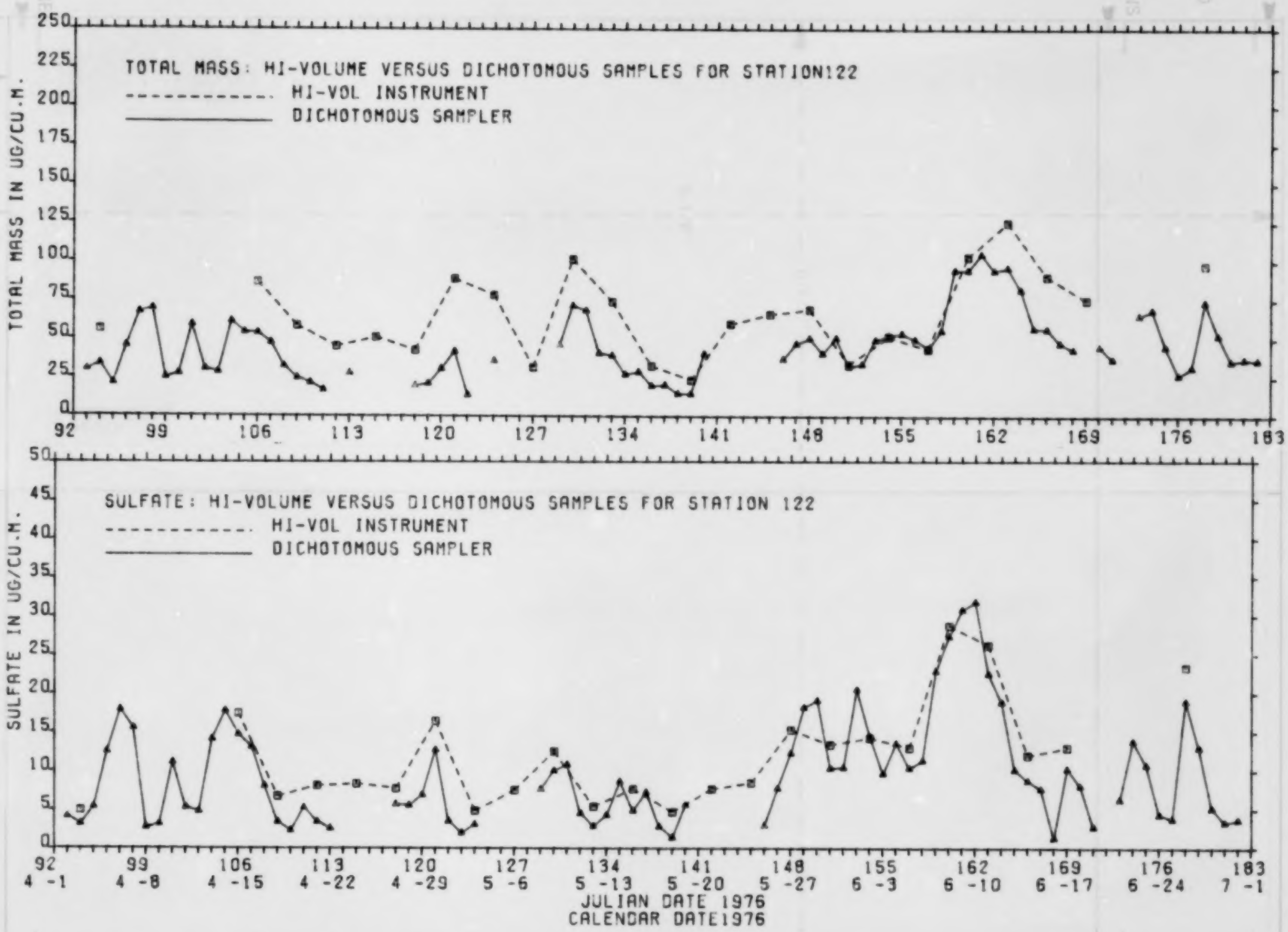

Figure C.68 Comparison of high volume versus dichotomous samples at station 122.

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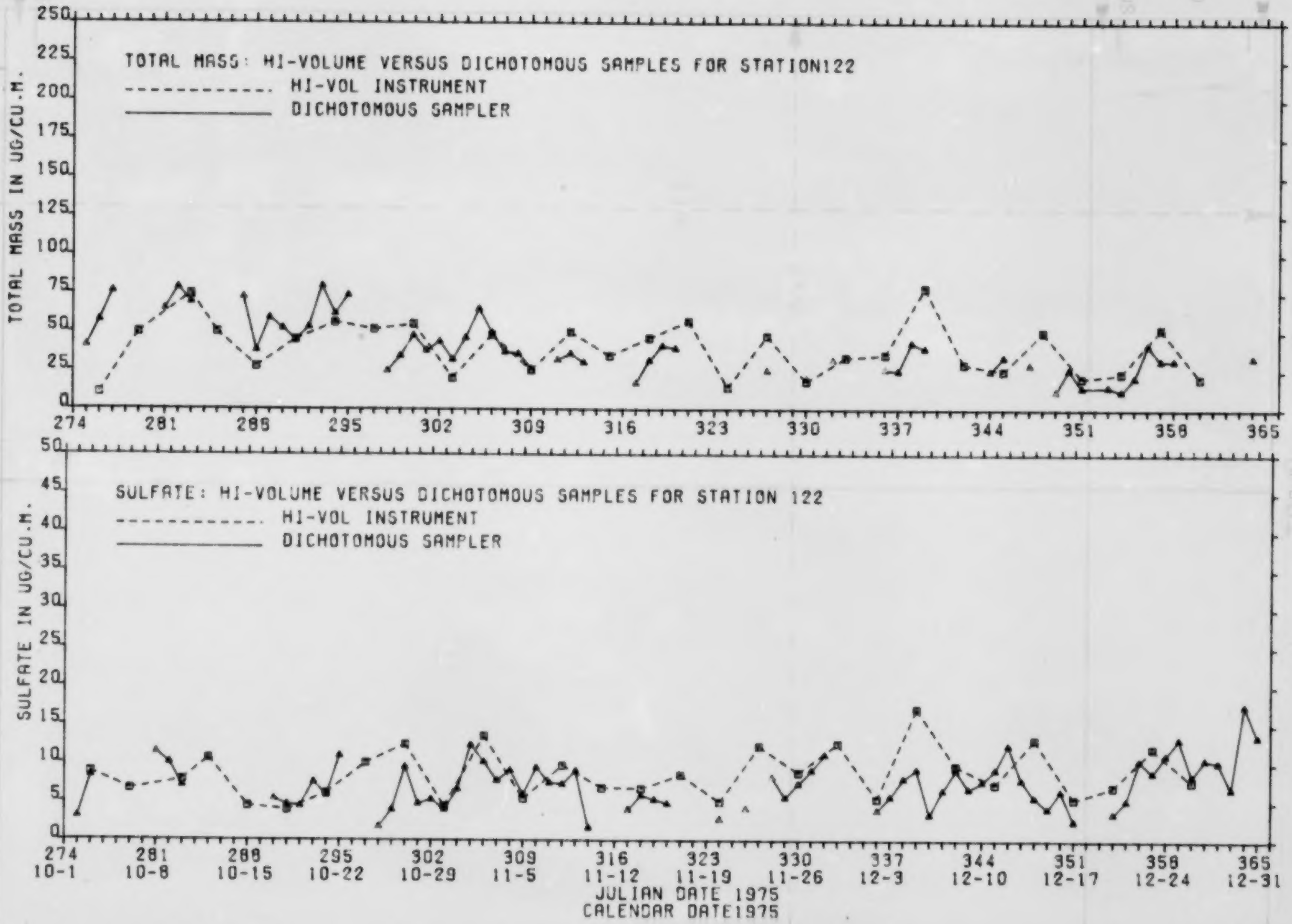

Figure C.69 Comparison of high volume versus dichotomous samples at station 122.

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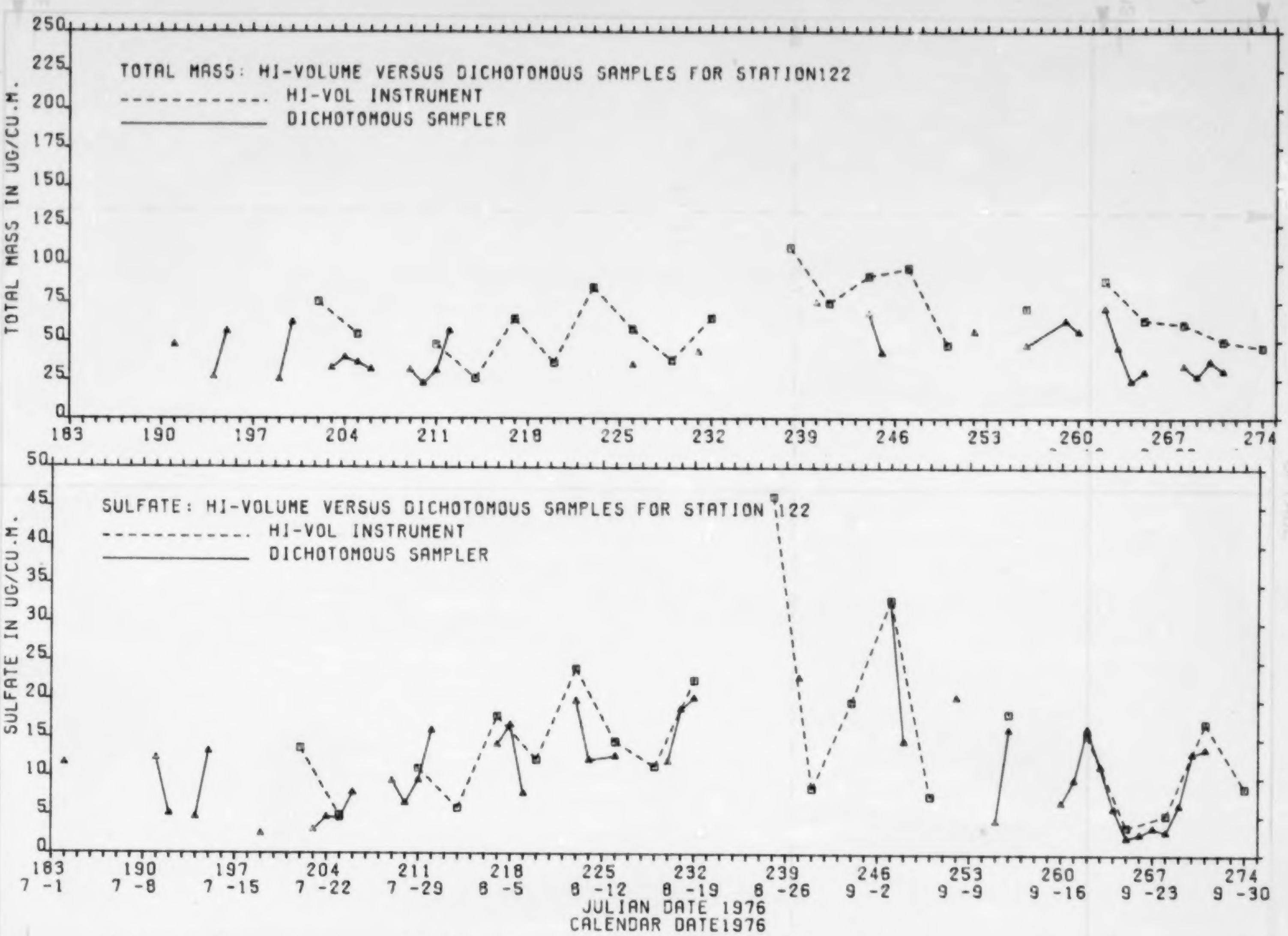

Figure C.70 Comparison of high volume versus dichotomous samples at station 122.

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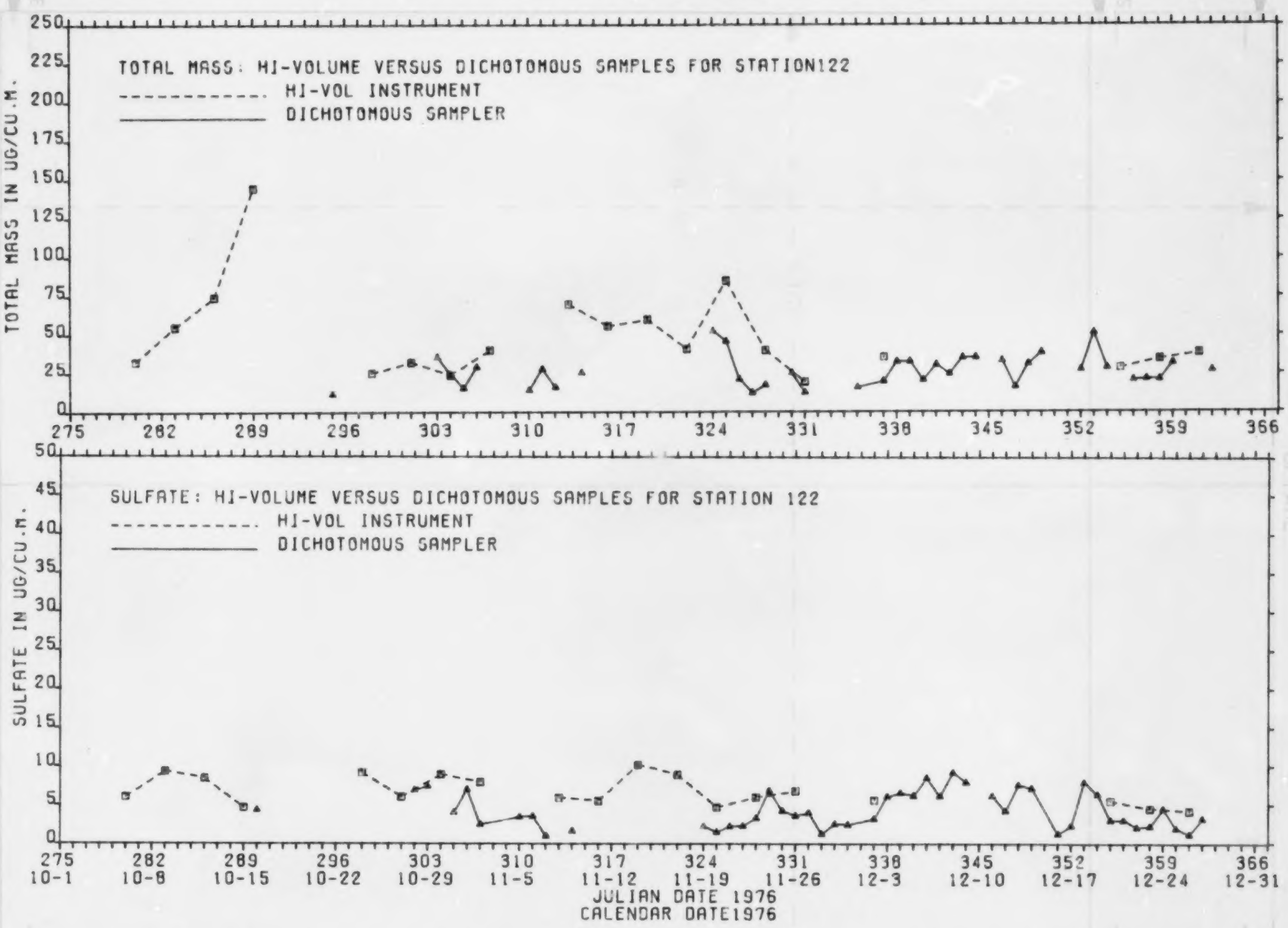

Figure C.71 Comparison of high volume versus dichotomous samples at station 122.

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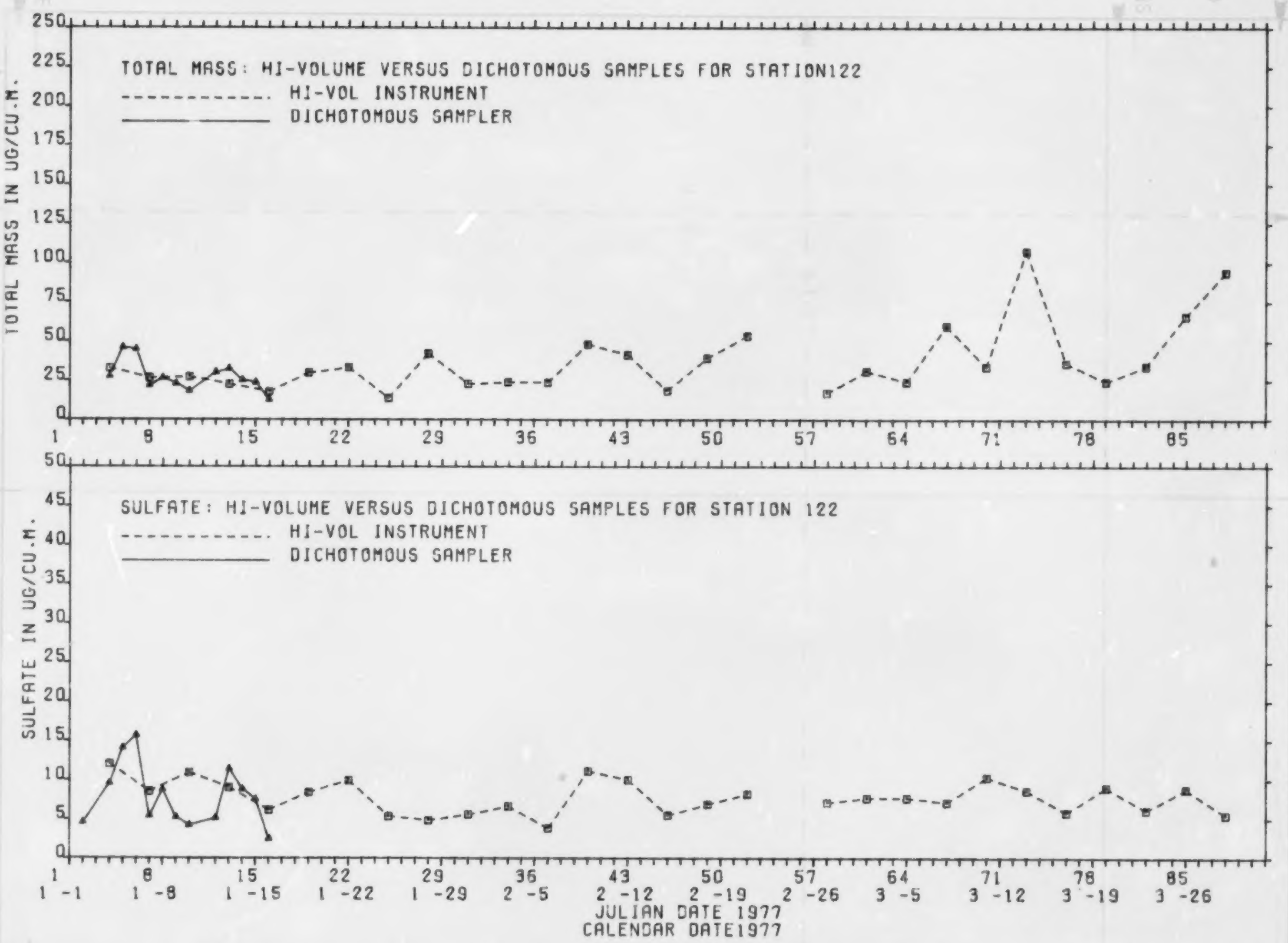

Figure C.72 Comparison of high volume versus dichotomous samples at station 122.

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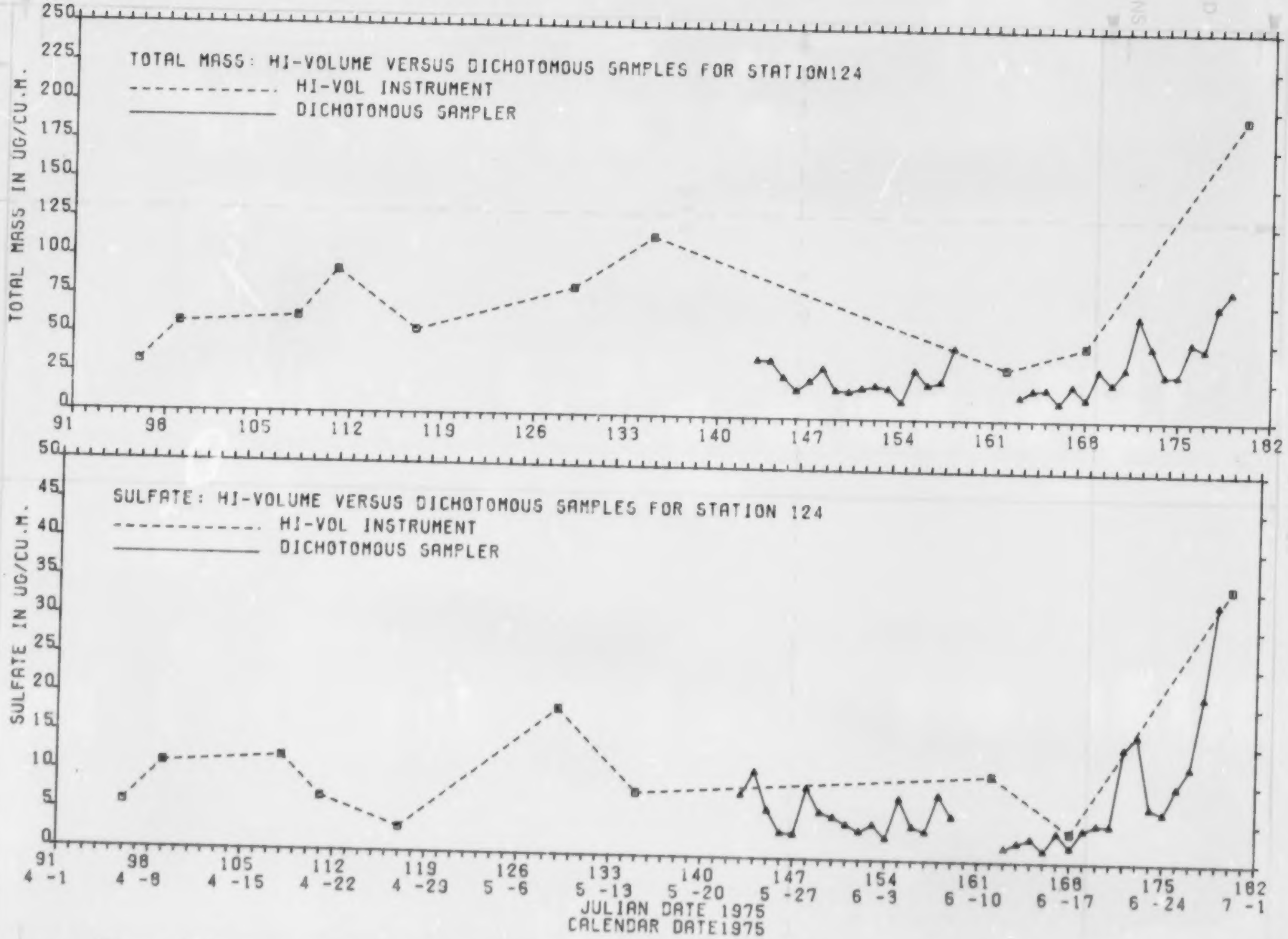

Figure C.73 Comparison of high volume versus dichotomous samples at station 124.

EPA-287 (Cin.)
(4-76)

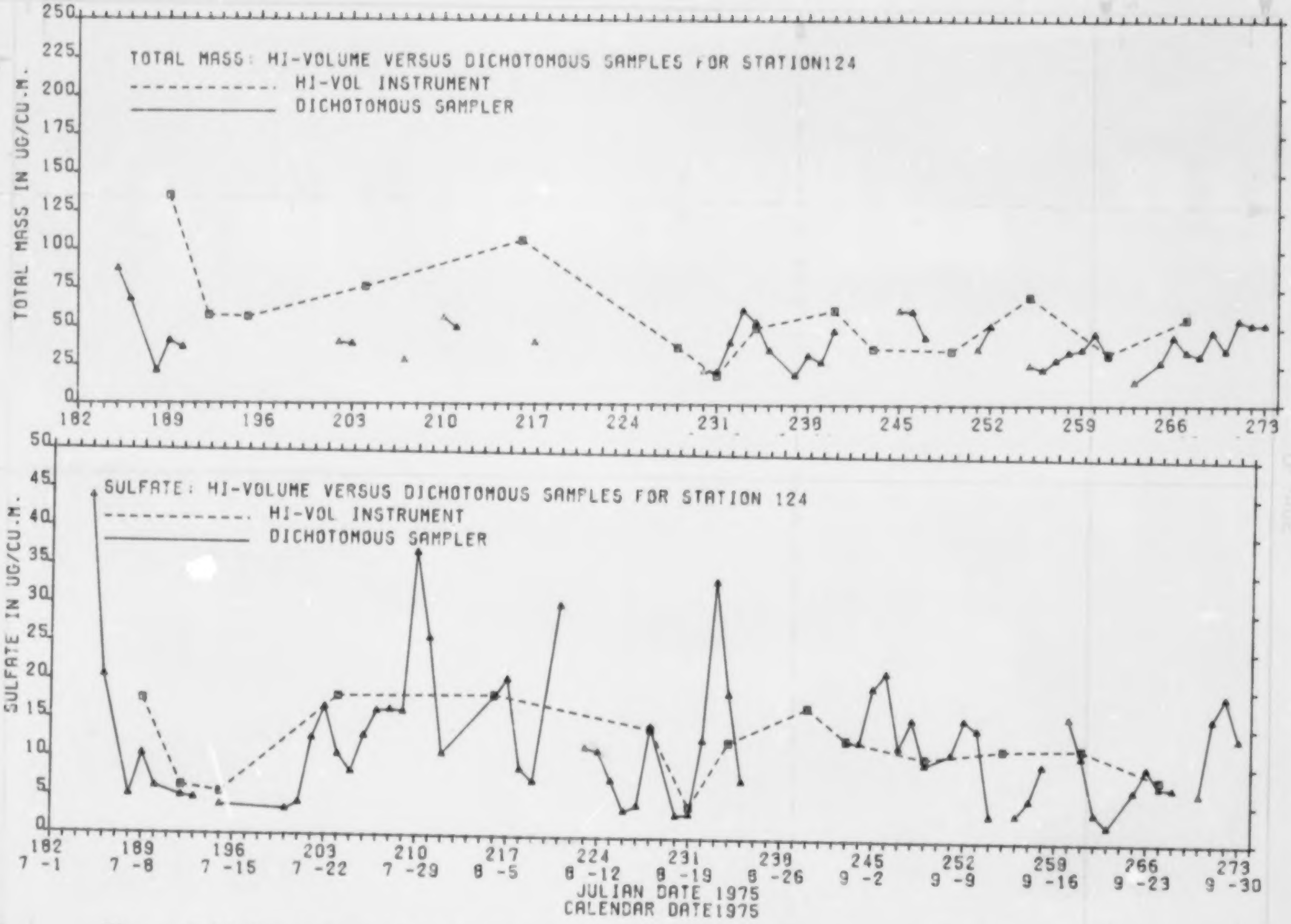

Figure C.74 Comparison of high volume versus dichotomous samples at station 124.

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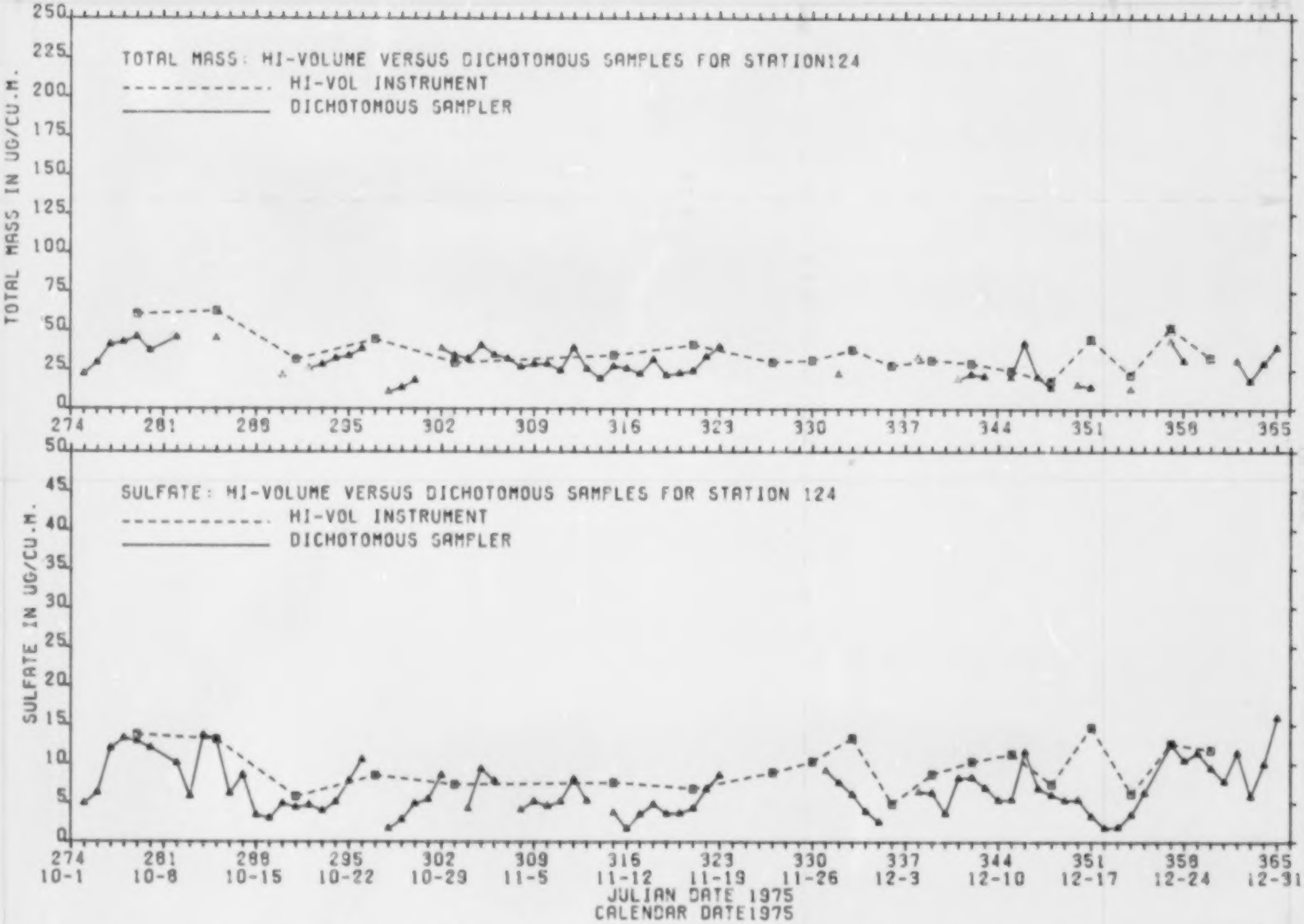

Figure C.75 Comparison of high volume versus dichotomous samples at station 124.

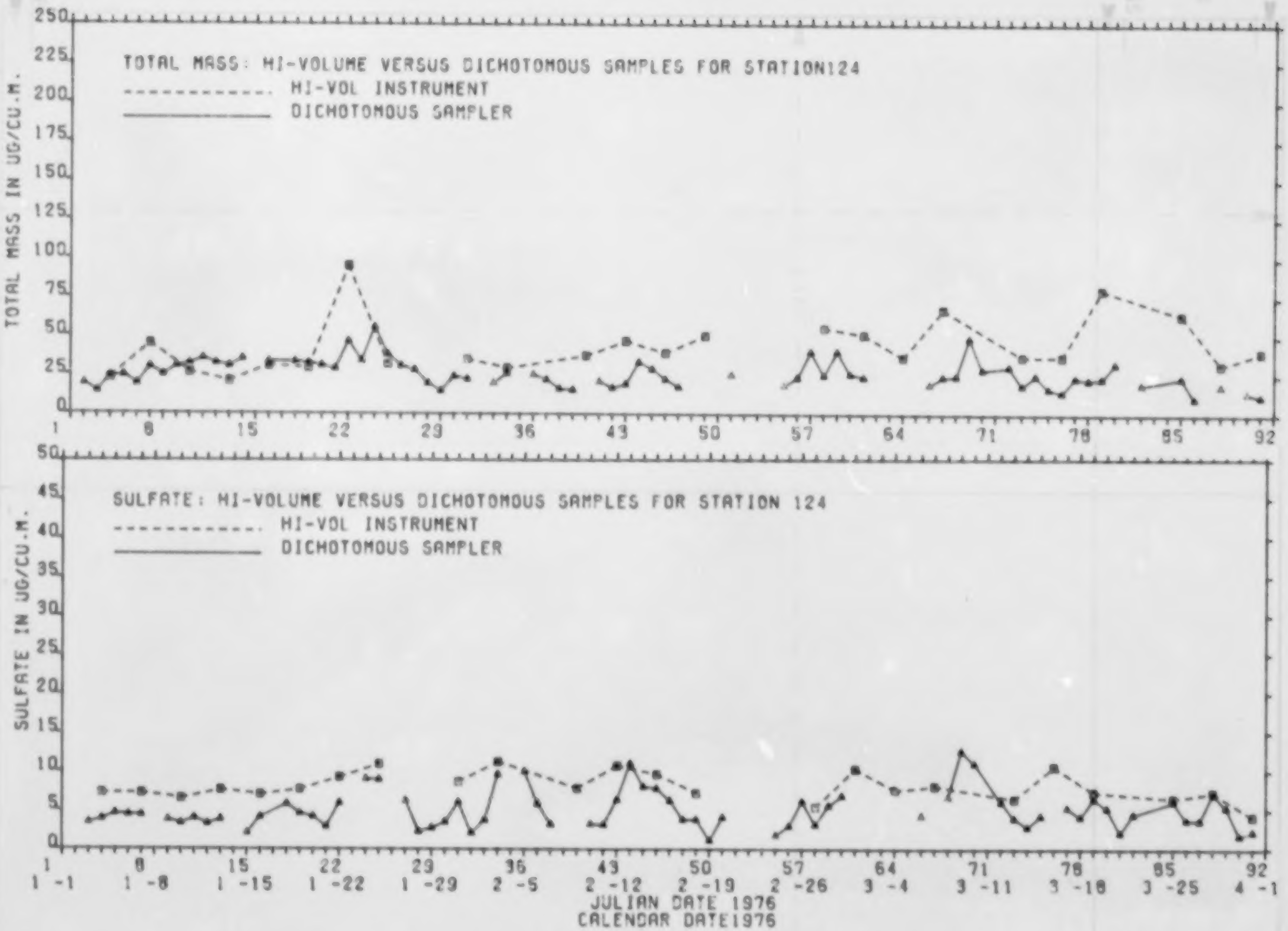

Figure C.76 Comparison of high volume versus dichotomous samples at station 124.

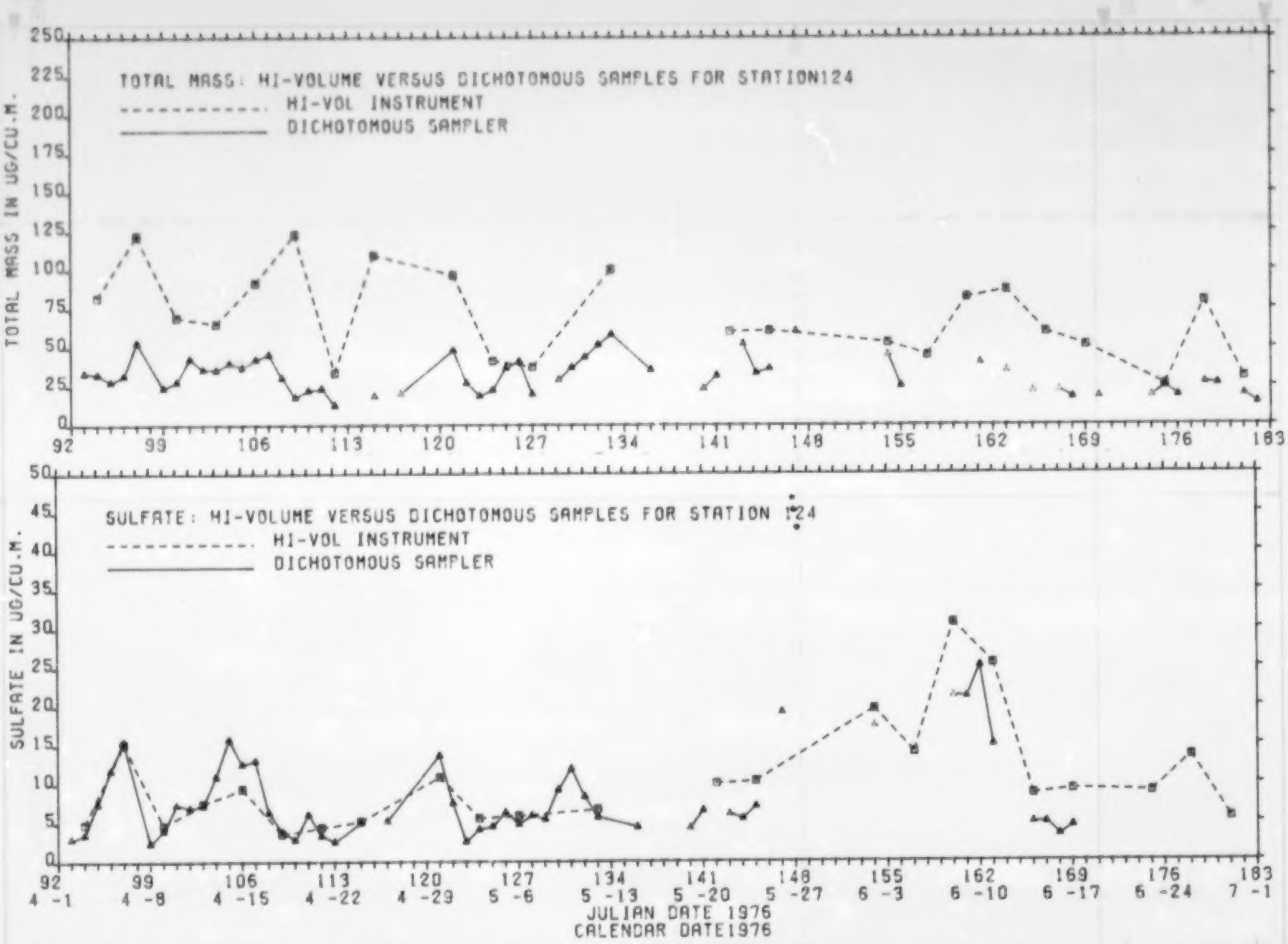

Figure C.77 Comparison of high volume versus dichotomous samples at station 124.

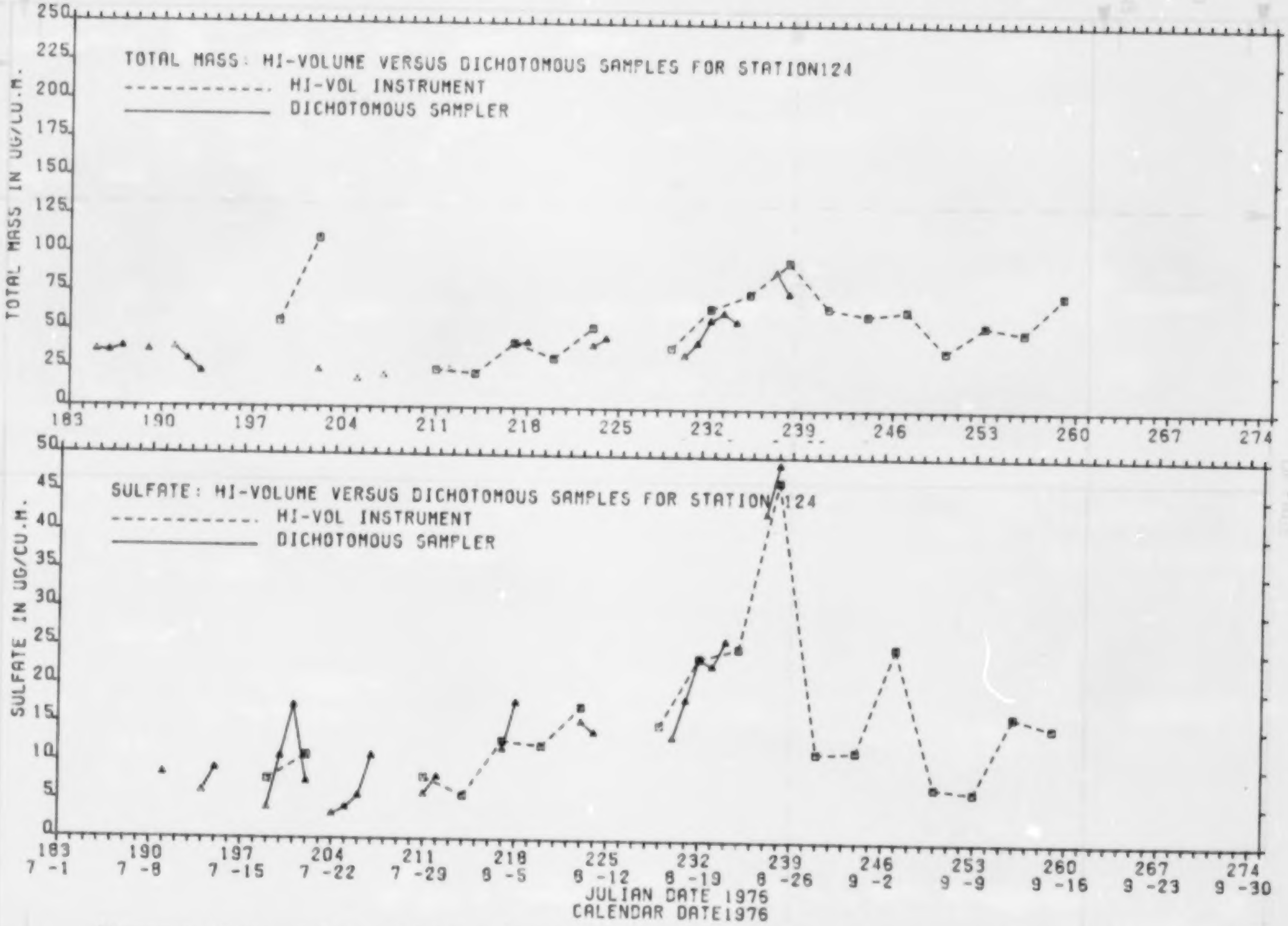

Figure C.78 Comparison of high volume versus dichotomous samples at station 124.

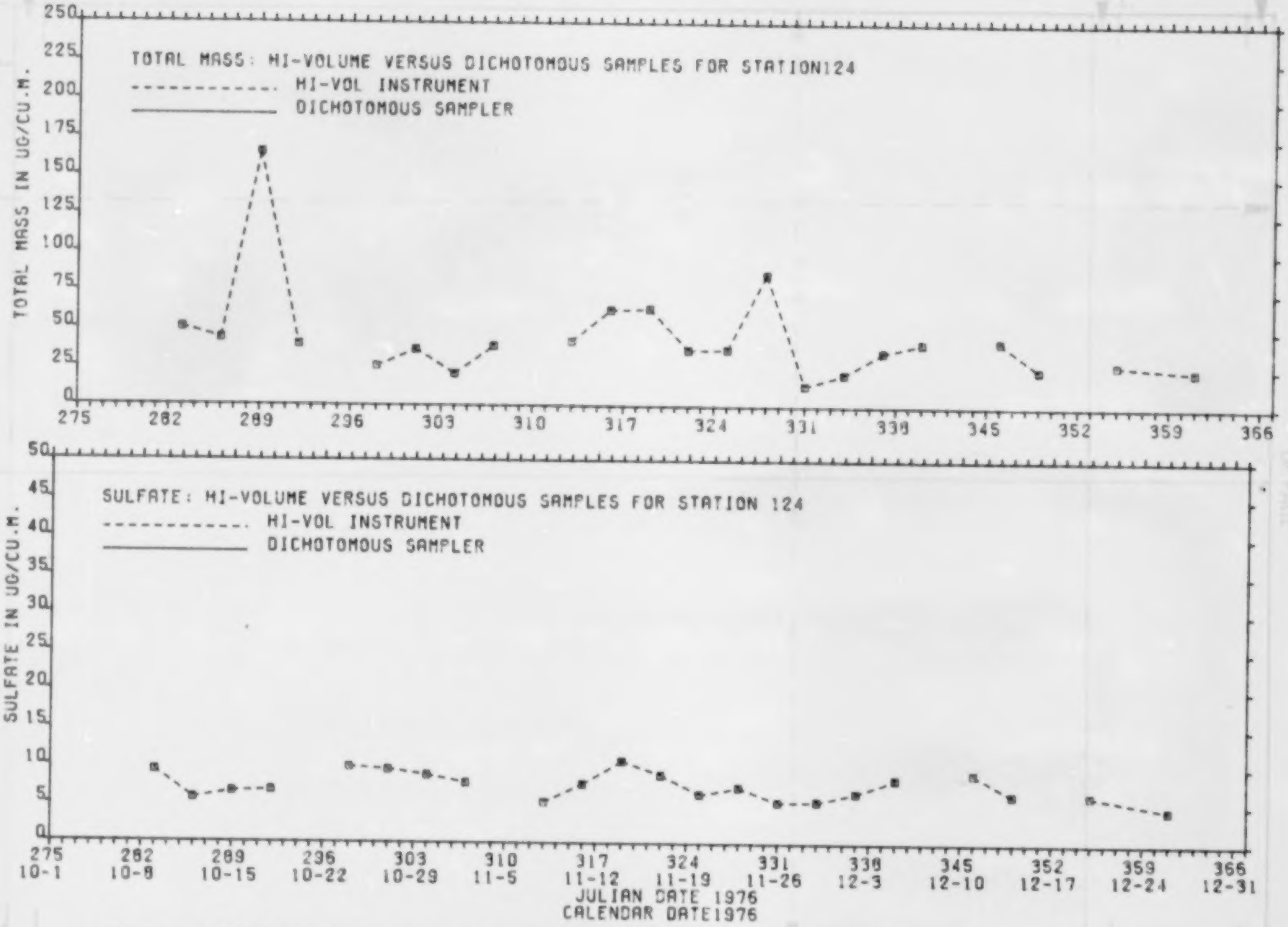

Figure C.79 Comparison of high volume versus dichotomous samples at station 124.

APPENDIX D

QUARTERLY RATIOS OF HIGH VOLUME TO DICHOTOMOUS MEASUREMENTS FOR TOTAL MASS AND SULFATE BY STATION

EPA-287 (Cin.)
(8-78)

TABLE D.1 QUARTERLY HIVOLUME TO DICHOTOMOUS 24 HR AVERAGES
STATION 103

			Hivolume			Dichotomous			Ratio		
Pollutant	Year	Qtr.	No. of cases	Mean*	std. dev.	No. of cases	Mean*	std. dev.	No. of cases	Mean	std. dev.
Mass	1975	2	16	102.6	32.8	13	64.7	20.9	4	2.23	0.38
		3	28	97.5	39.5	73	68.0	30.7	16	1.62	0.95
		4	28	93.1	36.8	83	47.2	25.1	24	2.39	1.06
	1976	1	23	90.4	30.1	66	45.1	16.5	17	2.00	0.70
		2	21	94.5	37.7	76	71.3	34.9	16	1.38	0.44
		3	25	101.4	28.1	48	71.3	27.3	12	1.49	0.33
		4	27	88.0	39.2	63	48.0	27.9	16	2.06	0.68
	1977	1	27	72.1	34.5	63	33.2	18.4	15	2.18	0.94
	All	All	197	91.9	35.7	486	54.9	29.8	120	1.93	0.85
Sulfate	1975	2	16	12.20	7.76	13	18.84	11.06	4	0.97	0.27
		3	28	14.13	6.62	73	14.66	9.85	16	1.59	1.42
		4	28	12.04	5.57	83	7.52	3.63	23	1.69	0.61
	1976	1	23	10.19	3.71	66	6.91	3.44	18	1.58	0.37
		2	21	13.31	7.11	76	12.33	9.13	18	1.23	0.26
		3	25	15.32	5.45	48	15.65	8.40	12	1.19	0.29
		4	27	9.81	4.13	63	7.41	4.49	21	1.44	0.40
		1	28	9.90	3.40	63	7.00	2.68	20	1.55	0.47
	All	All	198	12.17	5.84	486	10.28	7.63	132	1.47	0.65

* Units are ug/m^3

TABLE D.2 QUARTERLY HIVOLUME TO DICHOTOMOUS 24 HR AVERAGES
STATION 105

			Hivolume			Dichotomous			Ratio		
Pollutant	Year	Qtr.	No. of cases	Mean*	std. dev.	No. of cases	Mean*	std. dev.	No. of cases	Mean	std. dev.
Mass	1975	2	22	94.6	34.7	10	83.9	29.0	2	1.38	0.01
		3	22	79.9	23.9	75	59.0	25.5	14	1.60	0.39
		4	29	83.6	28.7	81	56.5	26.2	23	1.50	0.46
	1976	1	27	79.2	31.4	76	31.4	12.6	20	2.75	0.74
		2	24	90.6	23.4	81	51.9	25.2	19	1.89	0.80
		3	23	90.8	32.5	64	48.9	29.2	12	1.97	0.87
		4	24	83.2	42.5	51	42.4	26.2	14	2.41	0.65
	1977	1	27	81.9	35.3	72	34.7	16.1	14	2.38	0.64
	All	All	204	85.9	32.3	510	47.5	26.0	118	2.04	0.78
Sulfate	1975	2	22	13.29	6.28	10	23.56	16.28	2	1.31	0.27
		3	22	14.69	7.69	75	14.23	8.42	15	1.16	0.33
		4	29	10.74	4.11	81	8.07	4.00	22	1.28	0.32
	1976	1	27	9.66	3.00	84	5.98	2.88	25	1.64	0.38
		2	24	14.22	7.32	81	9.96	6.59	23	1.30	0.27
		3	23	17.58	10.62	64	14.49	9.48	19	1.21	0.26
		4	24	8.13	4.13	51	6.33	4.20	15	1.50	0.30
		1	27	9.57	4.83	72	6.75	3.87	20	1.57	0.22
	All	All	204	11.99	6.78	518	9.65	7.39	141	1.39	0.34

* Units are ug/m^3

TABLE D.3 QUARTERLY HIVOLUME TO DICHOTOMOUS 24 HR AVERAGES
STATION 106

			Hivolume			Dichotomous			Ratio		
Pollutant	Year	Qtr.	No. of cases	Mean*	std. dev.	No. of cases	Mean*	std. dev.	No. of cases	Mean	std. dev.
Mass	1975	2	18	79.9	26.9	24	50.6	22.0	5	2.05	0.29
		3	21	81.2	40.5	84	45.2	24.0	15	1.72	0.96
		4	24	66.7	31.3	78	40.4	17.7	19	1.75	0.75
	1976	1	27	67.5	33.3	83	34.6	12.1	23	2.15	1.15
		2	21	78.2	26.8	82	51.4	20.6	18	1.53	0.35
		3	25	84.2	28.9	46	61.5	28.6	15	1.40	0.29
		4	25	77.1	37.4	0	-	-	0	-	-
	1977	1	26	67.1	37.0	0	-	-	0	-	-
	All	All	191	75.5	33.6	397	45.5	22.1	95	1.76	0.82
Sulfate	1975	2	18	11.29	4.97	24	14.56	11.59	5	1.55	0.74
		3	21	18.76	11.23	84	14.15	9.51	16	1.30	0.51
		4	24	10.92	5.70	78	8.60	4.21	22	1.39	0.52
	1976	1	27	10.09	7.39	83	6.60	4.94	25	1.53	0.42
		2	21	12.97	6.76	82	11.20	7.69	21	1.16	0.23
		3	25	15.50	9.91	46	15.99	10.14	14	1.20	0.30
		4	25	8.11	3.86	0	-	-	0	-	-
		1	26	8.39	2.69	0	-	-	0	-	-
	All	All	191	11.94	7.80	397	11.11	8.37	103	1.35	0.45

* Units are ug/m^3

TABLE D.4 QUARTERLY HIVOLUME TO DICHOTOMOUS 24 HR AVERAGES
STATION 108

			Hivolume			Dichotomous			Ratio		
Pollutant	Year	Qtr.	No. of cases	Mean *	std. dev.	No. of cases	Mean *	std. dev.	No. of cases	Mean	std. dev.
Mass	1975	2	25	83.5	30.4	15	47.3	15.0	4	2.42	0.15
		3	26	88.9	36.8	66	49.4	20.5	18	1.89	0.78
		4	27	81.9	41.3	58	46.9	24.3	15	1.58	0.54
	1976	1	20	77.7	41.3	76	35.3	20.0	15	2.40	2.12
		2	23	91.9	36.9	76	54.9	24.4	19	1.86	0.85
		3	19	85.0	34.4	43	53.6	25.0	6	1.55	0.27
		4	28	75.3	38.1	45	33.6	16.9	10	1.92	0.72
	1977	1	23	63.9	44.9	19	29.0	15.1	4	2.67	1.01
	All	All	198	80.4	38.0	398	45.0	23.1	91	1.96	1.09
Sulfate	1975	2	25	13.06	5.71	15	14.03	7.95	4	1.40	0.16
		3	26	18.57	10.42	65	13.95	8.90	20	1.38	0.50
		4	27	12.49	5.07	58	8.84	4.14	18	1.57	0.82
	1976	1	20	11.20	4.17	76	7.46	3.78	18	1.51	0.67
		2	23	12.09	6.52	76	11.00	7.96	19	1.19	0.26
		3	19	13.30	5.87	43	13.38	7.75	8	1.24	0.28
		4	28	9.48	4.46	45	6.61	3.17	13	1.74	0.94
		1	23	10.16	4.13	19	8.21	5.07	5	2.02	1.06
	All	All	198	12.54	6.56	397	10.23	6.95	105	1.47	0.66

* Units are ug/m^3

TABLE D.5 QUARTERLY HIVOLUME TO DICHOTOMOUS 24 HR AVERAGES
STATION 112

			Hivolume			Dichotomous			Ratio		
Pollutant	Year	Qtr.	No. of cases	Mean *	std. dev.	No. of cases	Mean *	std. dev.	No. of cases	Mean	std. dev.
Mass	1975	2	23	85.7	32.3	19	57.1	30.0	6	1.83	0.43
		3	27	104.9	60.9	74	56.4	32.3	12	1.82	1.56
		4	29	61.2	28.2	84	43.0	17.9	18	1.42	0.38
	1976	1	28	61.6	26.0	88	30.3	14.2	16	1.76	0.28
		2	26	82.8	34.8	83	48.6	22.8	25	1.82	0.68
		3	24	113.8	86.8	64	58.1	24.1	14	1.61	0.45
		4	25	60.4	29.1	67	29.3	15.8	16	1.99	0.71
	1977	1	25	58.7	30.8	34	35.1	17.6	8	1.57	0.26
	All	All	213	77.6	48.3	513	43.8	24.4	115	1.73	0.71
Sulfate	1975	2	23	12.38	8.30	19	14.12	12.18	6	1.49	0.39
		3	27	17.33	10.31	74	13.54	9.63	18	1.66	1.96
		4	29	10.38	5.28	84	8.60	3.85	22	1.29	0.72
	1976	1	28	8.95	2.77	88	5.92	2.72	28	1.48	0.34
		2	26	12.21	6.24	83	10.66	7.92	24	1.18	0.29
		3	24	17.35	9.87	64	13.84	7.86	17	1.14	0.21
		4	25	7.78	4.13	67	5.75	4.16	20	1.50	0.68
		1	25	7.90	2.78	34	7.17	4.60	8	1.57	0.51
	All	All	213	11.67	7.47	513	9.57	7.32	143	1.39	0.83

* Units are ug/m^3

TABLE D.6 QUARTERLY HIVOLUME TO DICHOTOMOUS 24 HR AVERAGES
STATION 115

			Hivolume			Dichotomous			Ratio		
Pollutant	Year	Qtr.	No. of cases	Mean*	std. dev.	No. of cases	Mean*	std. dev.	No. of cases	Mean	std. dev.
Mass	1975	2	16	62.2	21.0	4	66.1	14.8	1	0.90	-
		3	25	65.2	29.6	77	46.1	20.1	21	1.58	0.74
		4	26	49.5	21.3	87	34.7	15.5	23	1.37	0.24
	1976	1	23	41.9	14.1	68	25.6	9.9	21	1.62	0.40
		2	23	63.0	25.2	66	43.7	21.4	15	1.77	0.64
		3	26	73.9	32.7	58	42.3	22.5	10	1.37	0.24
		4	26	61.8	26.0	68	28.7	13.6	15	1.85	0.48
	1977	1	27	42.6	23.1	23	29.8	10.1	5	1.27	0.38
	All	All	196	57.1	26.7	451	36.7	18.9	111	1.57	0.52
Sulfate	1975	2	16	12.38	6.86	4	28.76	10.67	1	0.67	-
		3	25	16.18	10.74	77	14.01	9.65	22	1.35	0.69
		4	26	9.82	3.17	87	8.06	3.26	24	1.30	0.33
	1976	1	23	9.04	2.31	80	6.30	2.81	21	1.44	0.41
		2	24	11.18	6.17	70	9.11	6.61	16	1.25	0.38
		3	26	15.32	8.07	63	11.86	5.31	17	1.18	0.30
		4	26	9.03	3.59	68	6.35	2.63	21	1.48	0.41
		1	27	7.93	1.89	23	7.73	3.93	7	1.64	0.59
	All	All	197	11.31	6.61	472	9.31	6.46	129	1.35	0.46

* Units are ug/m^3

TABLE D.7 QUARTERLY HIVOLUME TO DICHOTOMOUS 24 HR AVERAGES
STATION 118

			Hivolume			Dichotomous			Ratio		
Pollutant	Year	Qtr.	No. of cases	Mean*	std. dev.	No. of cases	Mean*	std. dev.	No. of cases	Mean	std. dev.
Mass	1975	2	24	87.5	44.5	23	37.9	20.7	8	2.92	1.96
		3	25	67.2	29.1	56	36.4	23.3	11	1.87	1.05
		4	28	48.5	20.4	56	29.6	13.9	13	2.35	2.02
	1976	1	21	55.2	23.0	73	26.2	10.5	17	2.33	0.62
		2	24	78.6	36.0	76	41.5	16.5	22	2.22	1.71
		3	23	73.1	17.3	55	44.0	14.2	16	1.83	0.65
		4	18	53.4	20.4	65	28.3	12.7	13	2.21	0.94
	1977	1	16	46.6	17.4	26	25.1	9.6	4	1.53	0.31
	All	All	181	64.3	31.1	430	33.8	16.9	104	2.18	1.33
Sulfate	1975	2	24	9.77	4.54	23	12.19	10.71	8	1.39	1.00
		3	25	13.53	8.88	56	12.35	9.94	15	1.31	0.37
		4	28	9.86	3.40	56	6.96	3.33	16	1.50	0.44
	1976	1	21	9.38	2.90	73	5.34	2.60	15	1.84	0.60
		2	24	10.79	6.33	76	9.62	7.11	21	1.33	0.83
		3	23	13.90	6.83	55	11.60	6.51	15	1.25	0.27
		4	19	9.85	5.17	65	5.98	2.77	15	1.87	1.32
		1	16	7.76	1.80	26	6.04	3.64	5	2.15	0.57
	All	All	182	10.68	5.79	430	8.53	6.68	110	1.53	0.75

* Units are ug/m^3

TABLE D.8 QUARTERLY HIVOLUME TO DICHOTOMOUS 24 HR AVERAGES
STATION 120

			Hivolume			Dichotomous			Ratio		
Pollutant	Year	Qtr.	No. of cases	Mean*	std. dev.	No. of cases	Mean*	std. dev.	No. of cases	Mean	std. dev.
Mass	1975	2	12	86.5	58.1	6	66.2	25.7	1	4.20	-
		3	16	80.1	31.1	82	42.5	19.3	14	2.28	1.84
		4	21	51.0	33.7	79	40.4	19.6	15	1.37	1.24
	1976	1	25	44.7	17.5	62	25.8	8.5	17	1.81	0.77
		2	23	54.6	19.5	79	39.6	14.2	19	1.43	0.39
		3	24	57.2	16.5	61	43.0	22.3	13	1.14	0.43
		4	25	56.4	28.4	62	26.0	12.4	12	2.13	1.11
	1977	1	23	48.8	24.9	25	27.0	12.8	6	1.78	0.42
	All	All	173	57.3	30.4	456	36.7	18.0	97	1.71	1.09
Sulfate	1975	2	12	14.43	14.25	6	23.69	15.39	1	3.66	-
		3	16	19.69	14.15	82	10.68	7.67	15	2.50	1.66
		4	21	9.46	3.71	79	6.12	3.37	14	2.01	2.18
	1976	1	25	8.06	2.64	62	5.25	3.08	13	2.33	1.94
		2	23	10.96	6.16	79	9.34	6.40	21	1.20	0.34
		3	24	12.21	6.02	61	11.68	6.90	19	1.27	0.43
		4	25	7.16	2.53	62	4.70	2.79	17	1.87	0.69
		1	23	7.23	2.74	25	6.26	4.11	6	1.75	0.79
	All	All	173	10.54	7.62	456	8.17	6.44	106	1.80	1.35

* Units are ug/m^3

TABLE D.9 QUARTERLY HIVOLUME TO DICHOTOMOUS 24 HR AVERAGES
STATION 122

			Hivolume			Dichotomous			Ratio		
Pollutant	Year	Qtr.	No. of cases	Mean*	std. dev.	No. of cases	Mean*	std. dev.	No. of cases	Mean	std. dev.
Mass	1975	2	25	62.4	40.5	39	29.8	18.5	11	2.75	1.48
		3	26	57.8	23.7	79	43.3	23.1	19	1.43	0.85
		4	29	39.5	17.5	75	34.1	18.2	21	1.28	0.62
	1976	1	25	39.3	13.7	67	22.2	9.2	20	1.97	0.57
		2	24	65.9	26.6	74	44.4	21.9	19	1.82	1.11
		3	21	64.2	21.9	46	37.9	15.2	9	1.61	0.25
		4	20	51.7	31.1	46	23.6	10.3	8	1.80	0.46
	1977	1	29	37.2	21.7	14	26.1	9.6	5	1.21	0.32
	All	All	206	50.8	27.4	436	34.4	19.6	112	1.72	0.92
Sulfate	1975	2	25	13.72	14.56	39	8.92	7.51	11	1.92	1.10
		3	26	14.87	7.99	79	12.22	8.77	20	1.31	0.69
		4	29	8.58	3.29	75	7.14	3.33	22	1.36	0.44
	1976	1	25	8.70	2.98	67	5.29	2.63	20	1.55	0.32
		2	24	11.99	6.69	74	9.63	6.98	20	1.52	0.55
		3	21	15.28	10.17	46	11.68	7.31	13	1.20	0.23
		4	20	7.58	4.22	42	4.15	2.32	9	2.26	0.86
		1	29	7.68	2.07	14	7.59	3.98	6	1.74	0.70
	All	All	206	10.84	7.87	436	8.56	6.63	121	1.53	0.66

* Units are ug/m^3

TABLE D.10 QUARTERLY HIVOLUME TO DICHOTOMOUS 24 HR AVERAGES
STATION 124

Pollutant	Year	Qtr.	Hivolume No. of cases	Hivolume Mean*	Hivolume std. dev.	Dichotomous No. of cases	Dichotomous Mean*	Dichotomous std. dev.	Ratio No. of cases	Ratio Mean	Ratio std. dev.
Mass	1975	2	11	71.8	49.3	34	30.5	17.5		3.40	-
		3	15	78.9	80.9	76	34.2	16.3	12	2.22	1.13
		4	19	36.0	12.2	80	25.7	8.9	15	1.64	0.64
	1976	1	25	42.5	18.2	78	24.5	10.2	23	1.99	1.21
		2	23	70.0	28.9	73	29.3	12.0	20	2.52	1.42
		3	18	57.1	23.0	33	31.9	20.2	6	2.72	2.51
		4	23	45.9	31.6		-	-		-	-
	1977	1	10	34.2	10.8		-	-		-	-
	All	All	150	53.2	37.9	374	28.8	13.9	77	2.17	1.32
Sulfate	1975	2	11	9.08	4.23	34	7.26	6.39		1.96	-
		3	15	11.04	9.24	76	12.78	9.98	13	1.19	0.30
		4	19	15.63	14.17	80	6.52	3.30	14	1.69	0.90
	1976	1	25	9.64	2.97	78	5.04	2.54	22	1.56	0.37
		2	23	8.20	2.02	73	7.36	5.11	21	1.37	0.52
		3	18	10.42	6.88	33	12.45	10.70	7	1.28	0.36
		4	23	15.51	9.92		-	-		-	-
		1	10	8.07	3.64		-	-		-	-
	All	All	150	8.17	2.69	374	8.24	7.13	78	1.45	0.55

* Units are ug/m^3

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APPENDIX E

SCATTERPLOTS OF HIGH VOLUME VS. DICHOTOMOUS MEASUREMENTS FOR TOTAL MASS AND SULFATE BY STATION

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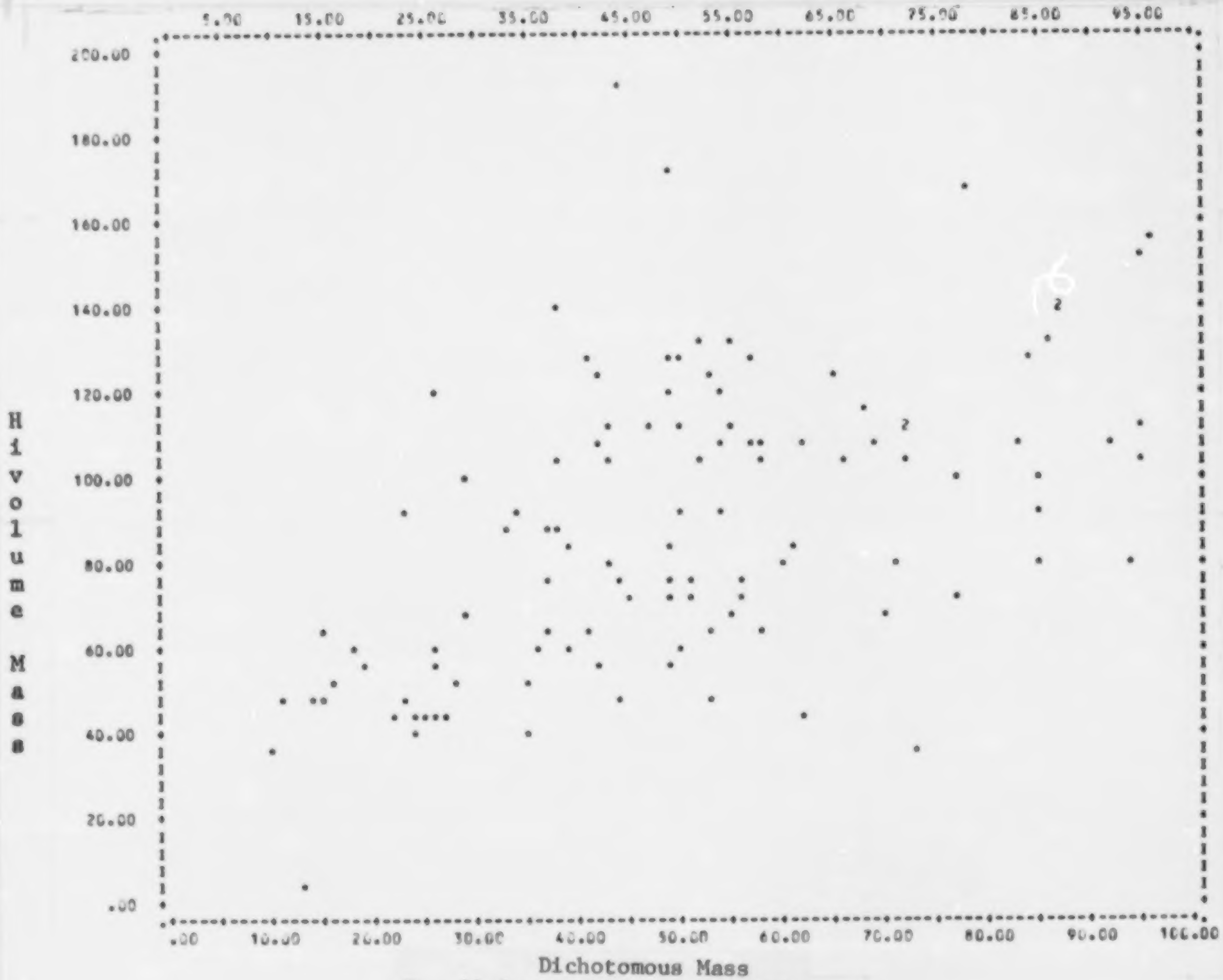
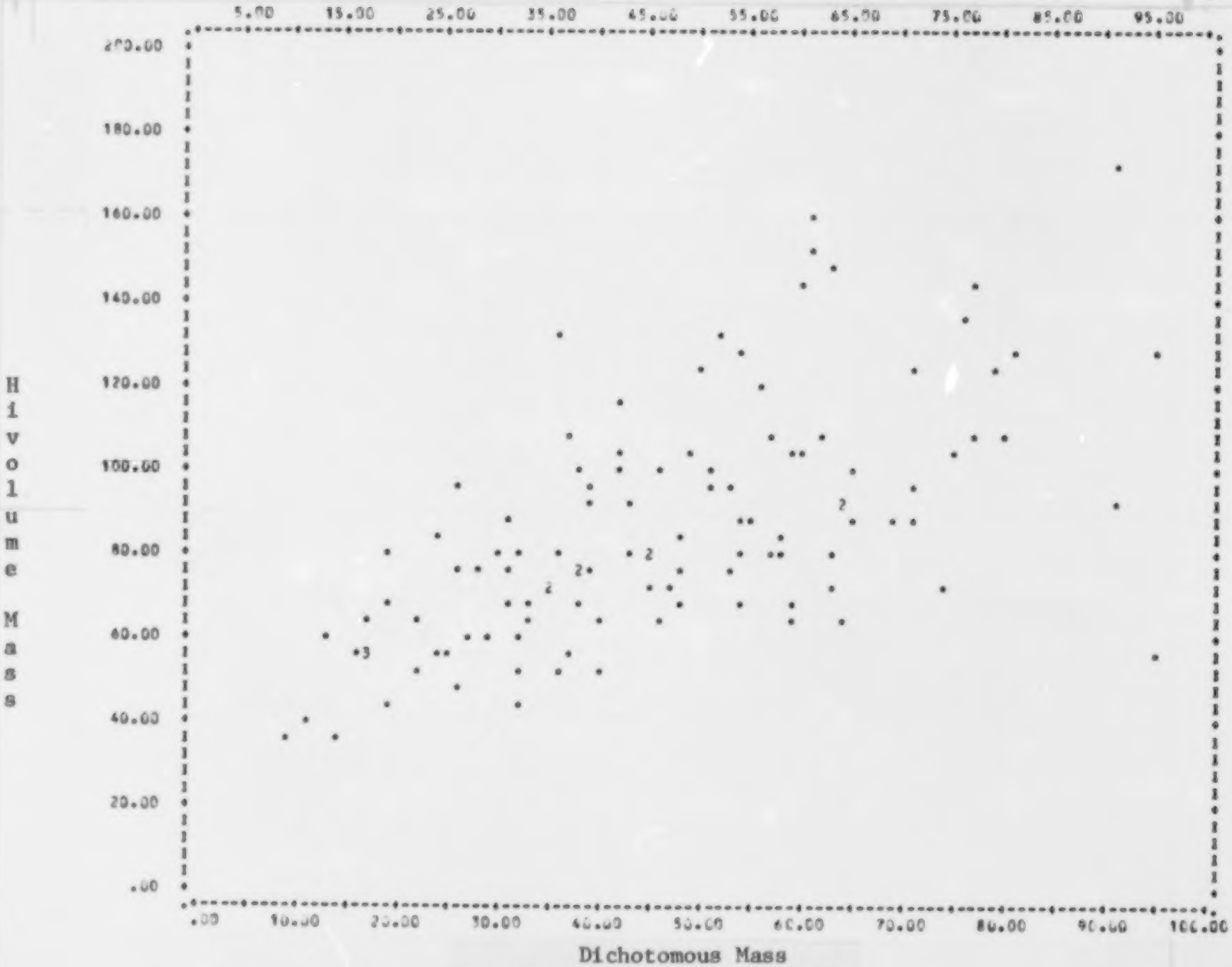


Y = 44.0 + 0.902X   R = 0.637

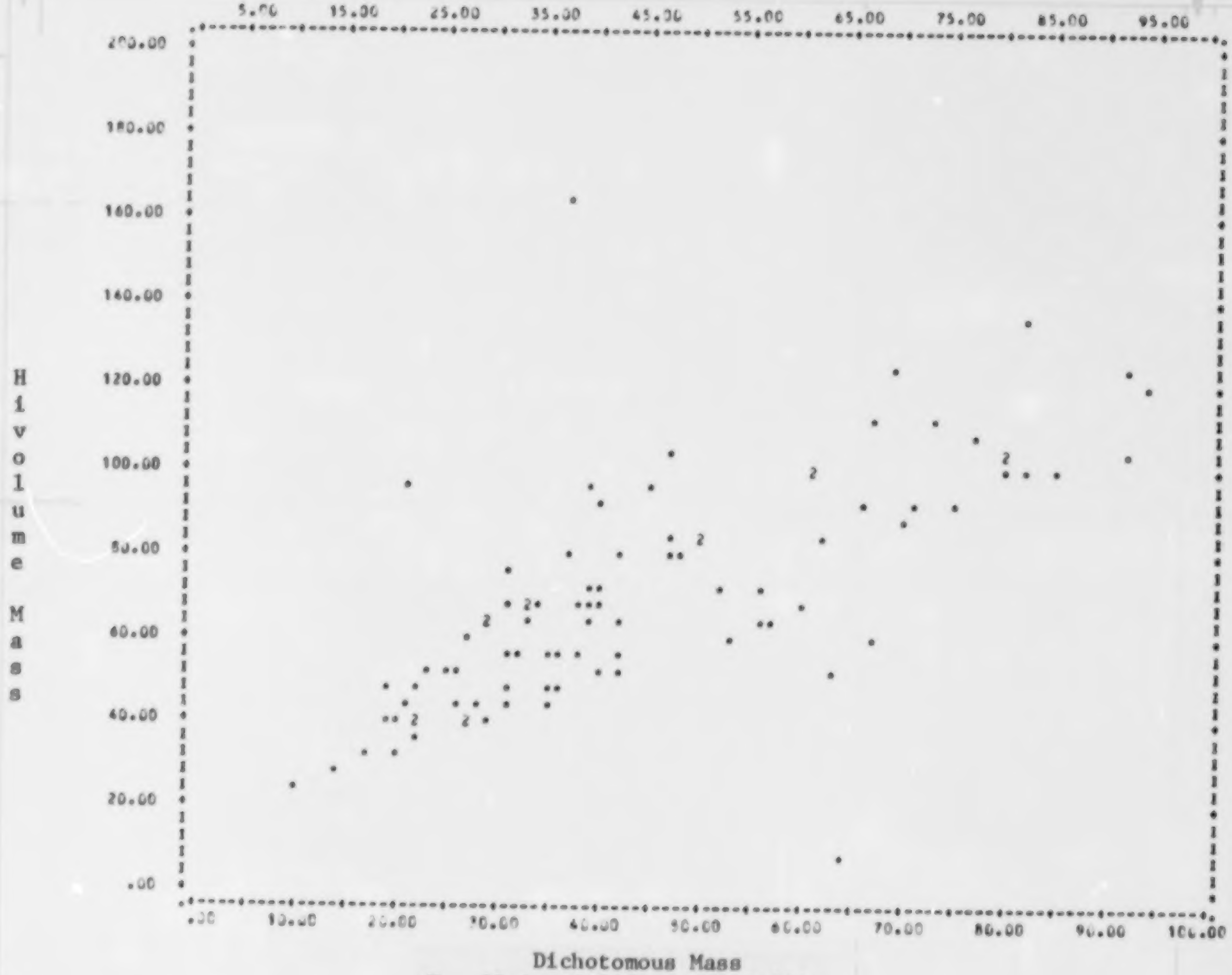
Figure E.1 Comparison of high volume and dichotomous sampler mass measurements at station 103.

103



Y = 49.5 + 0.786X   R = 0.646

Figure E.2   Comparison of high volume and dichotomous sampler mass measurements at station 105.



Y = 29.4 + 0.967X R = 0.666

Figure E.3 Comparison of high volume and dichotomous sampler mass measurements at station 106.

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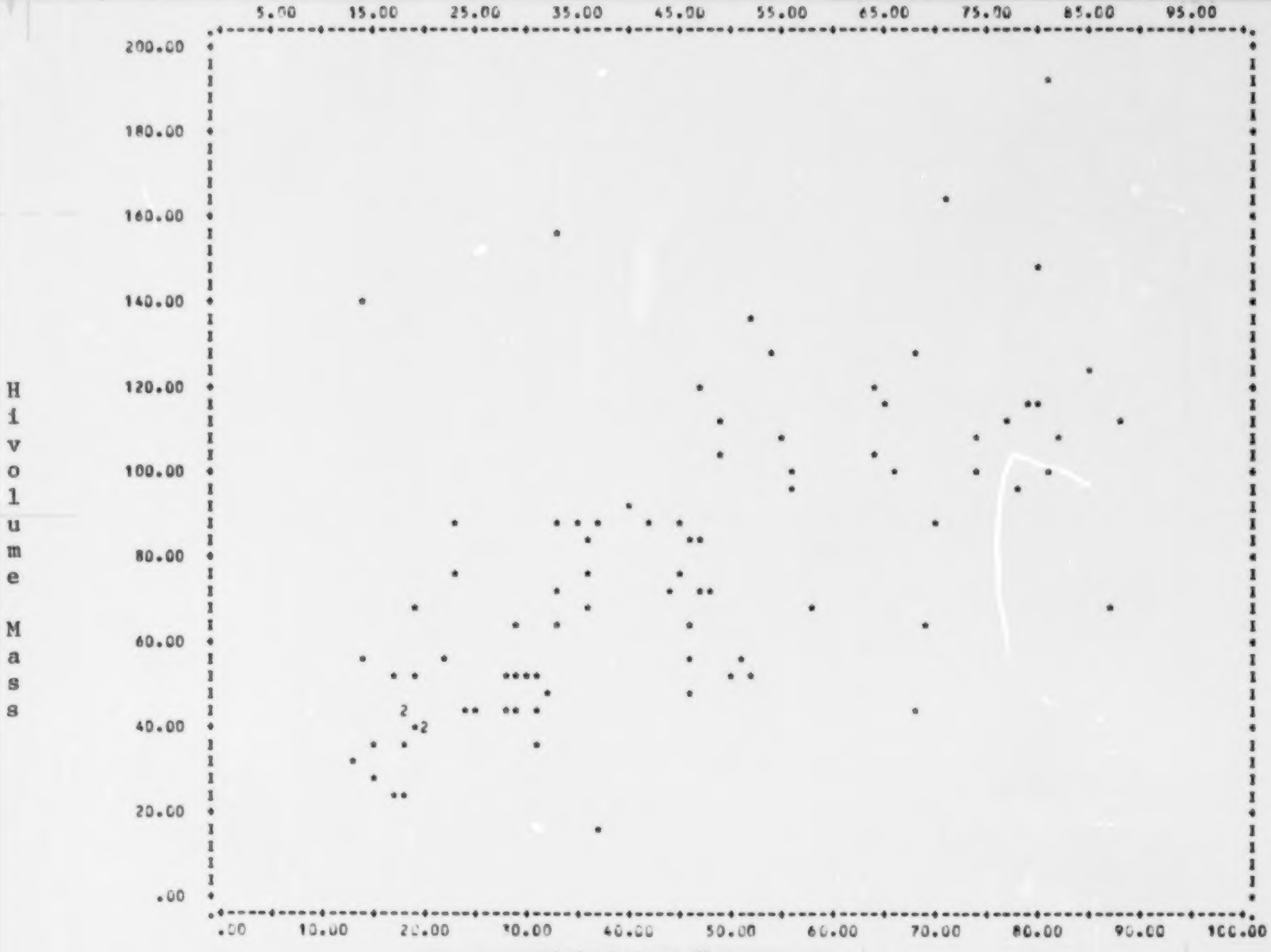
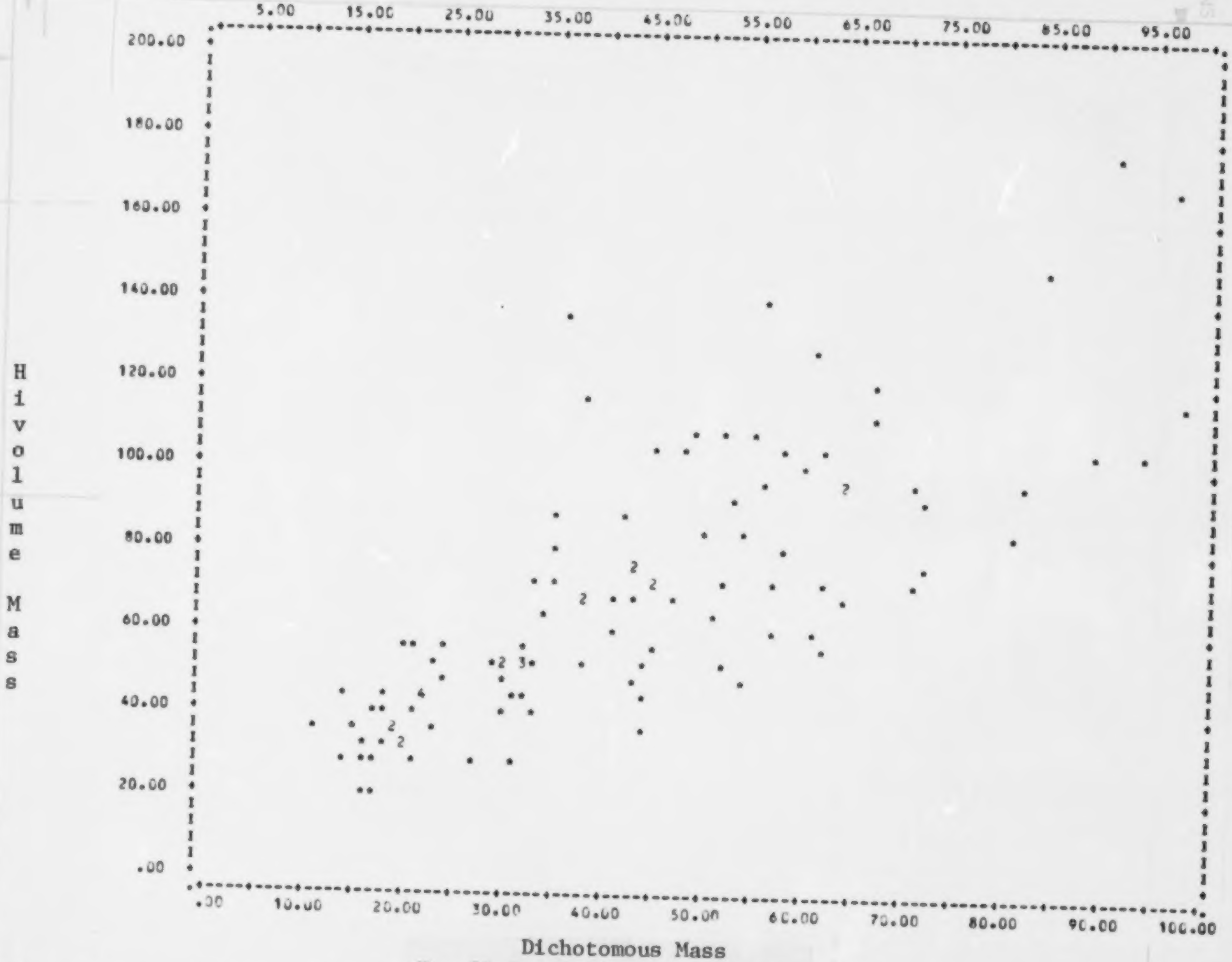


Y = 31.5 + 1.05X   R = 0.708

Figure E.4 Comparison of high volume and dichotomous sampler mass measurements at station 108.



Y = 21.1 + 1.14X   R = 0.722

Figure E.5 Comparison of high volume and dichotomous sampler mass measurements at station 112.

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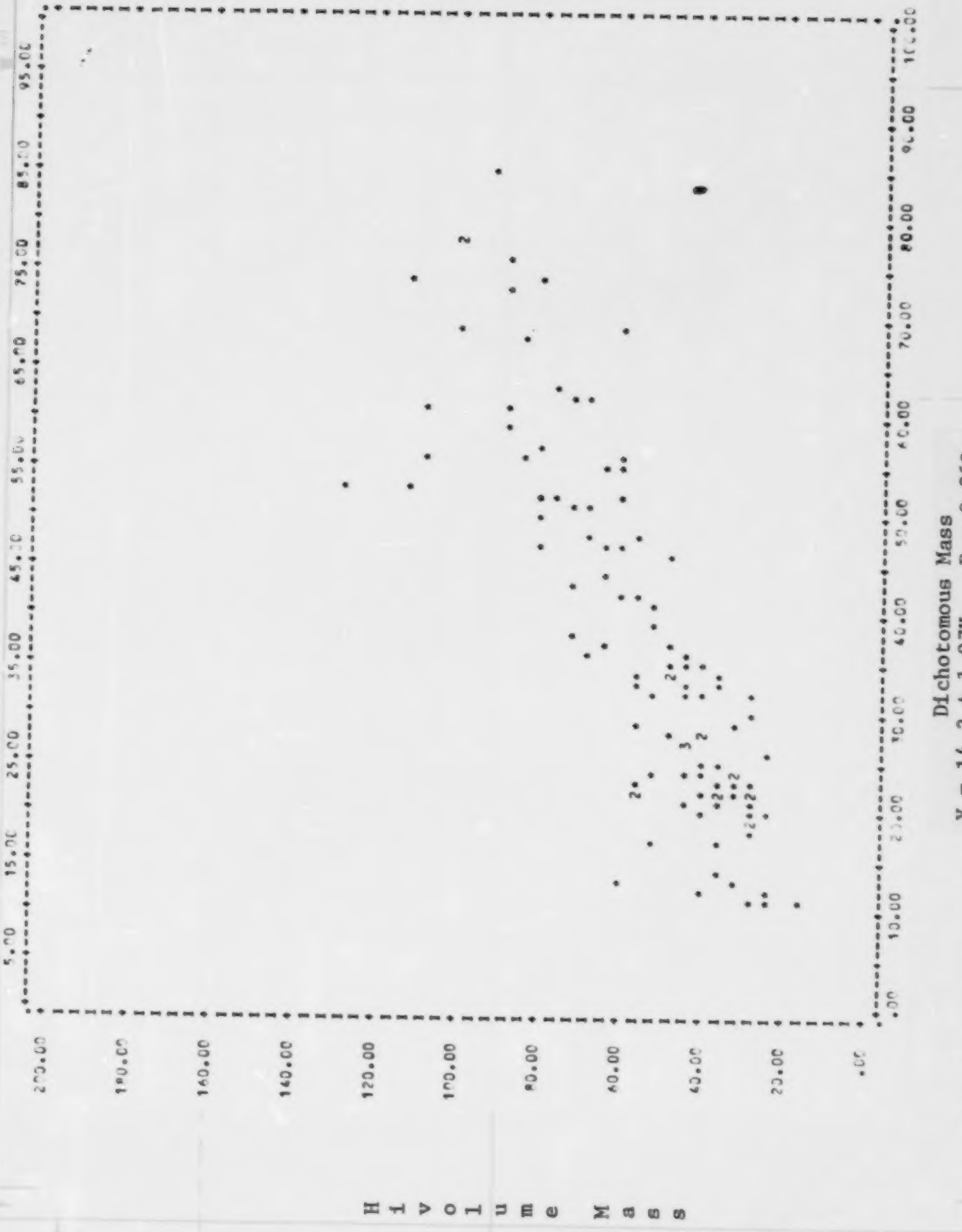

Y = 14.3 + 1.07X R = 0.860

Figure E.6 Comparison of high volume and dichotomous sampler mass measurements at station 115.

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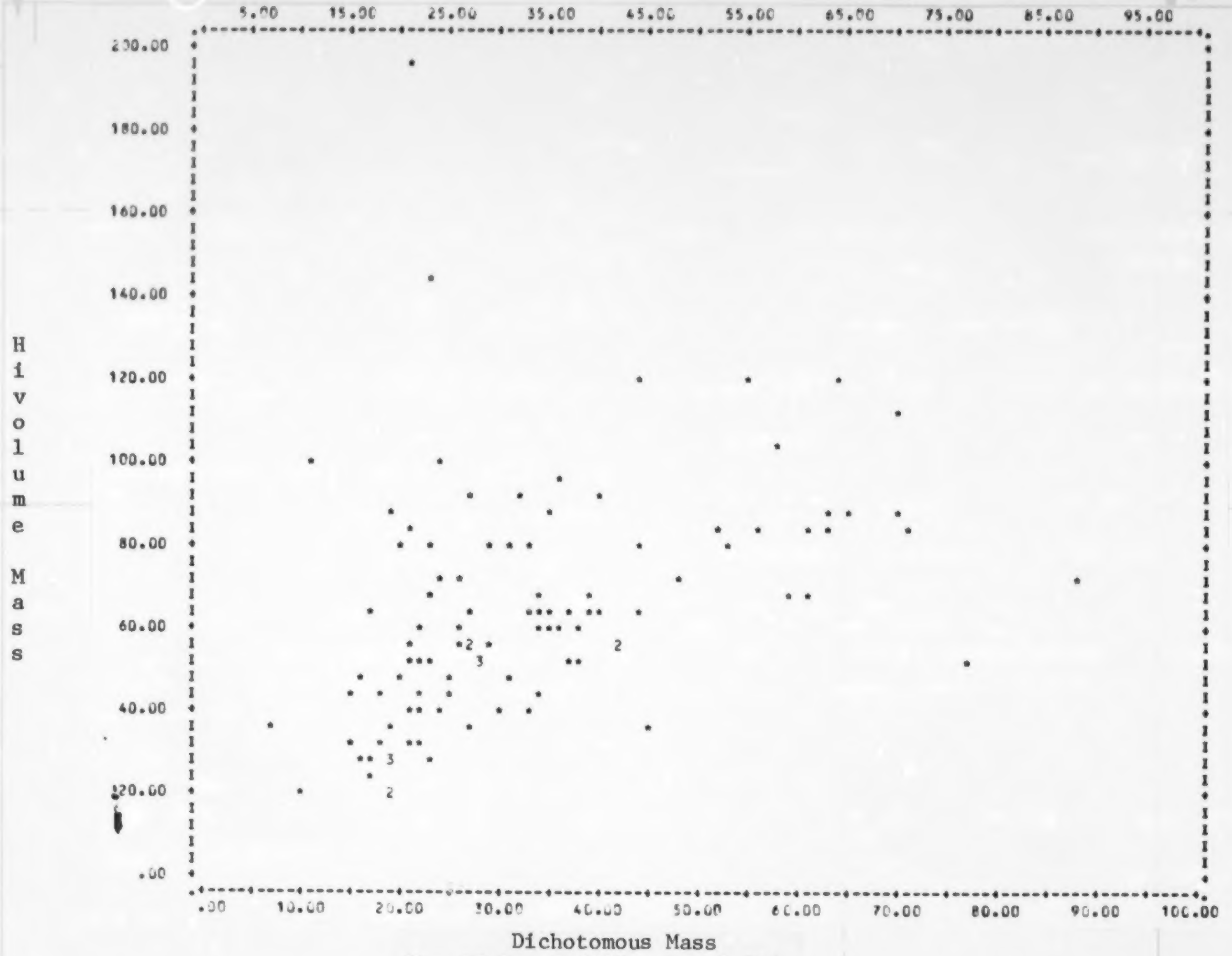
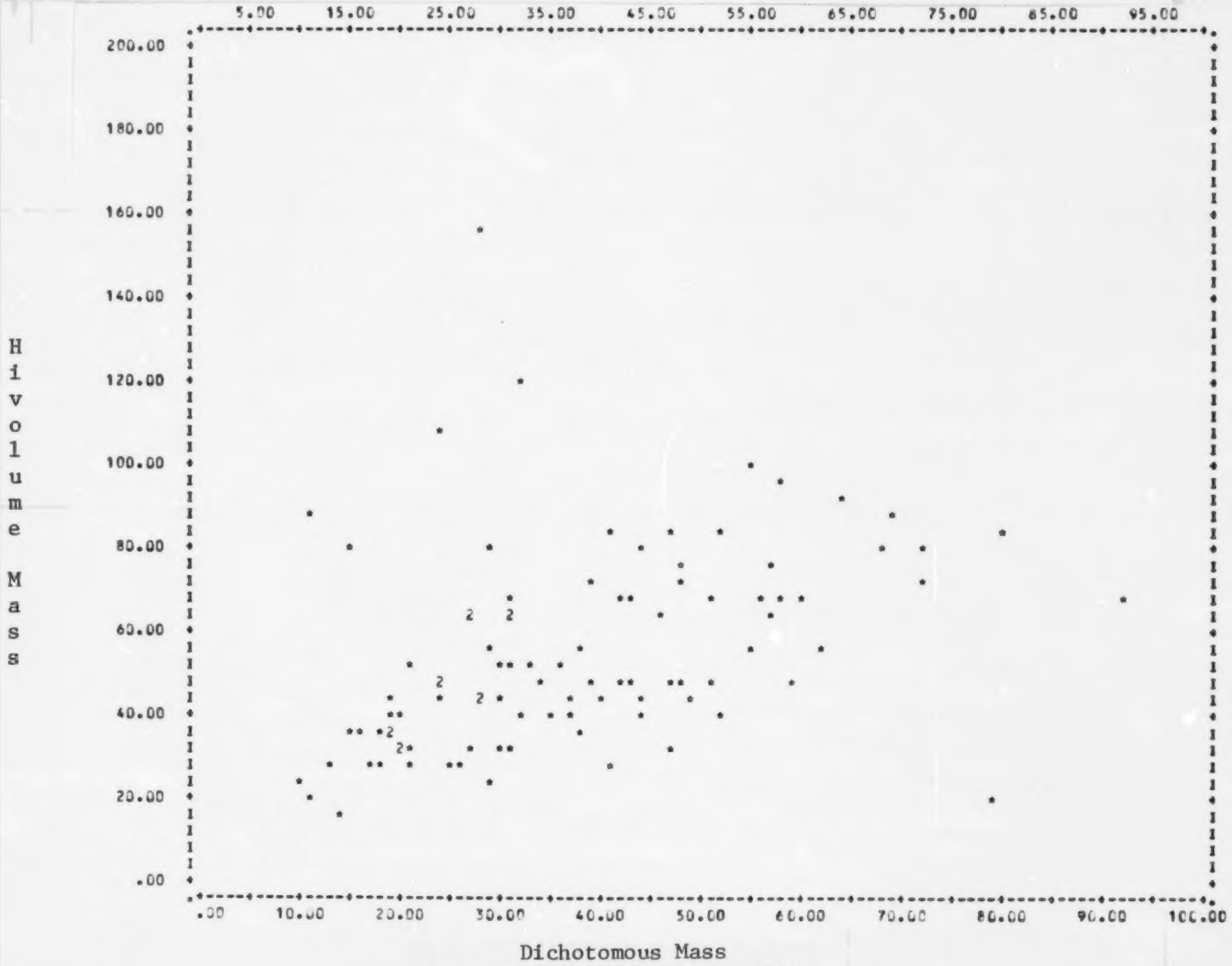


Y = 37.0 + 0.809X R = 0.514

Figure E.7 Comparison of high volume and dichotomous sampler mass measurements at station 118.



Y = 31.1 + 0.682X   R = 0.377

Figure E.8 Comparison of high volume and dichotomous sampler mass measurements at station 120.

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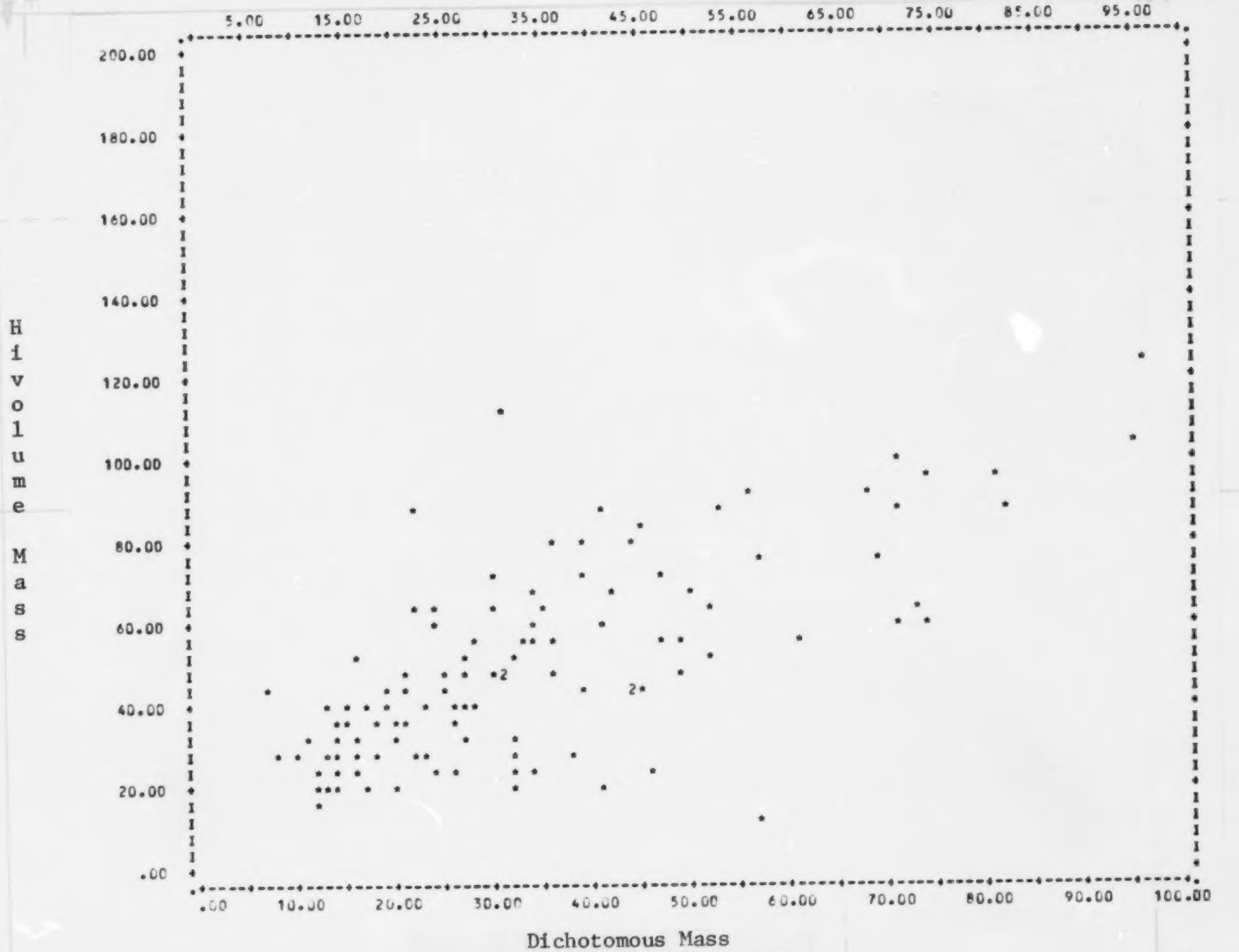

Y = 22.3 + 0.861X   R = 0.594

Figure E.9 Comparison of high volume and dichotomous sampler mass measurements at station 122.

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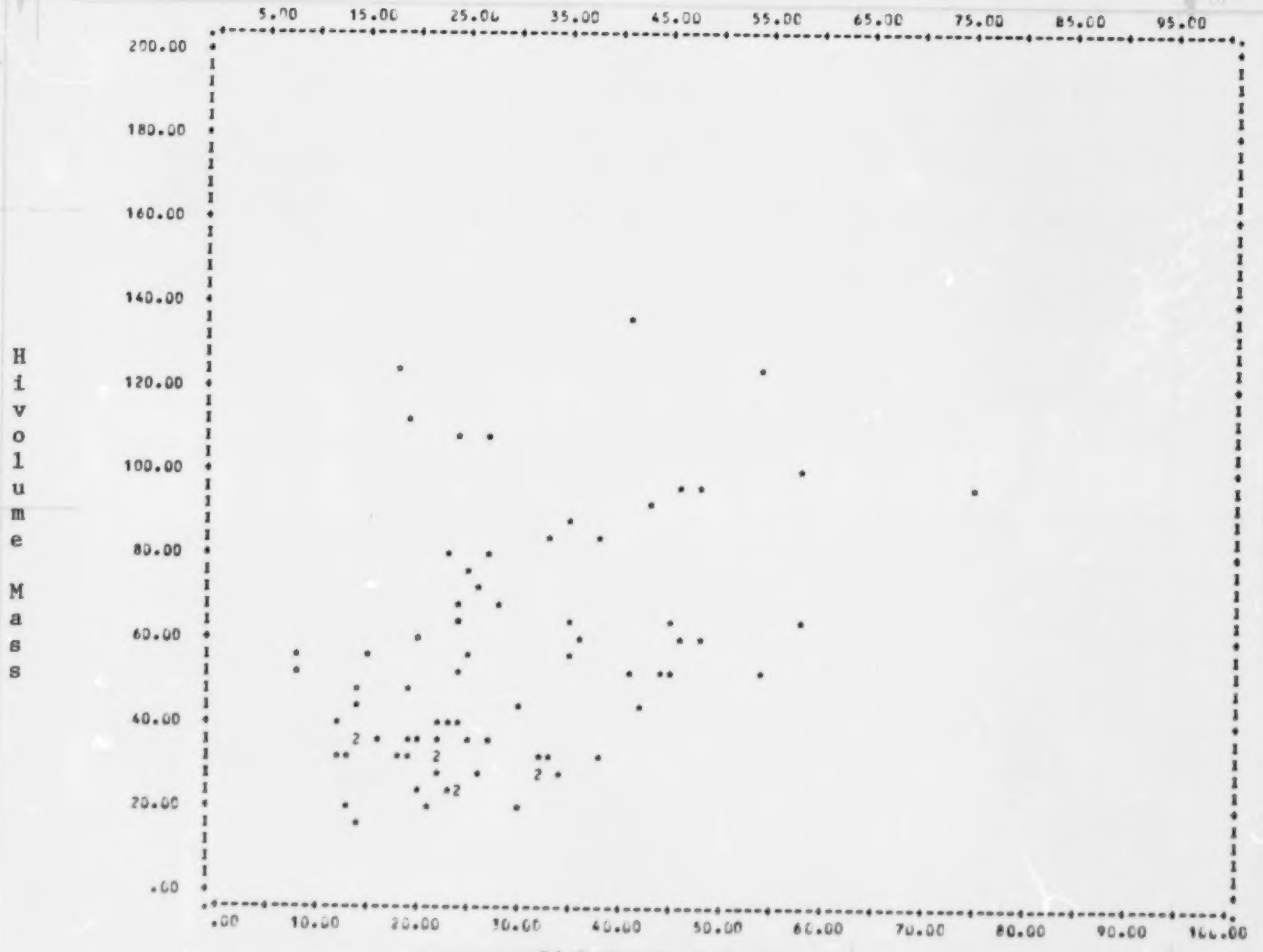
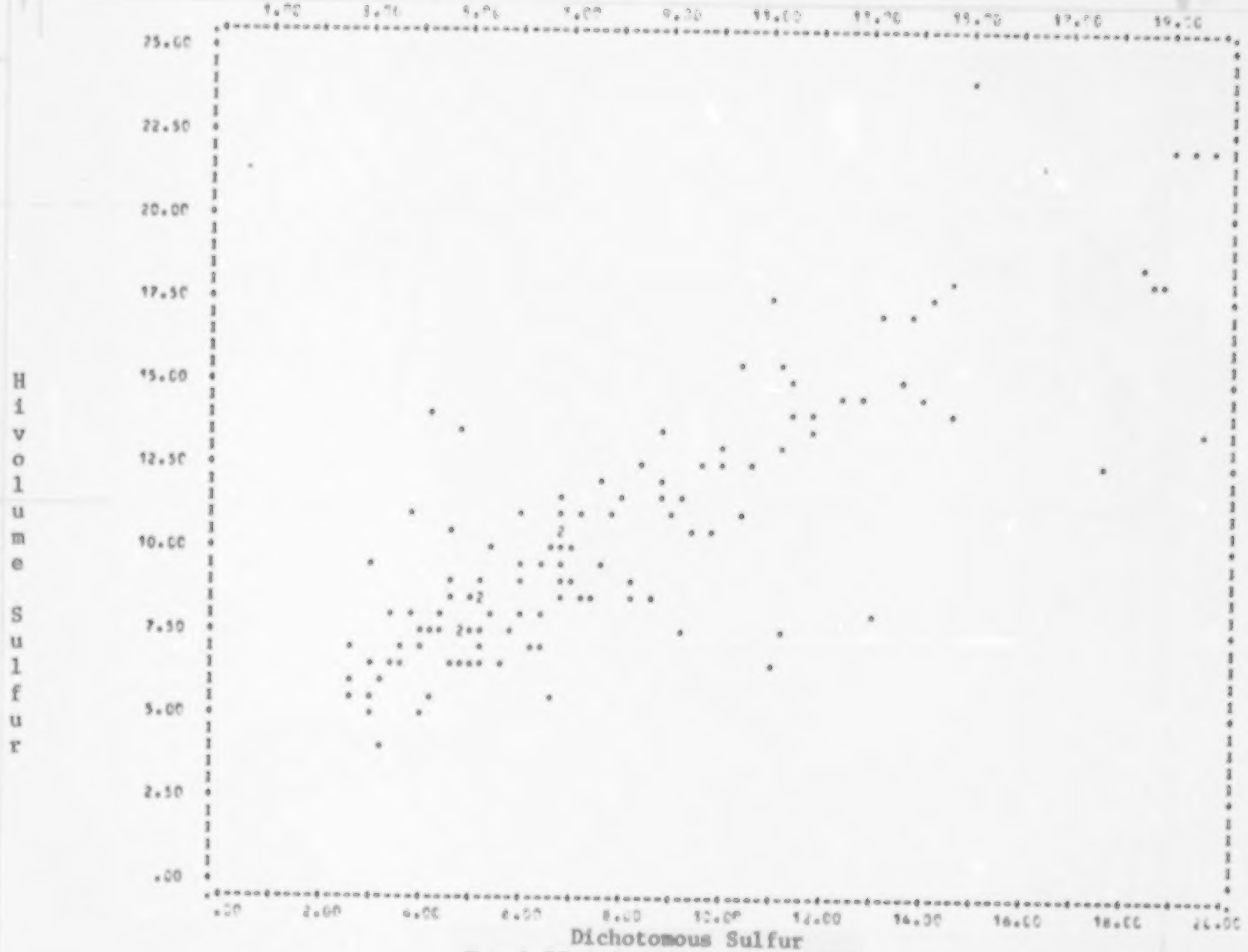


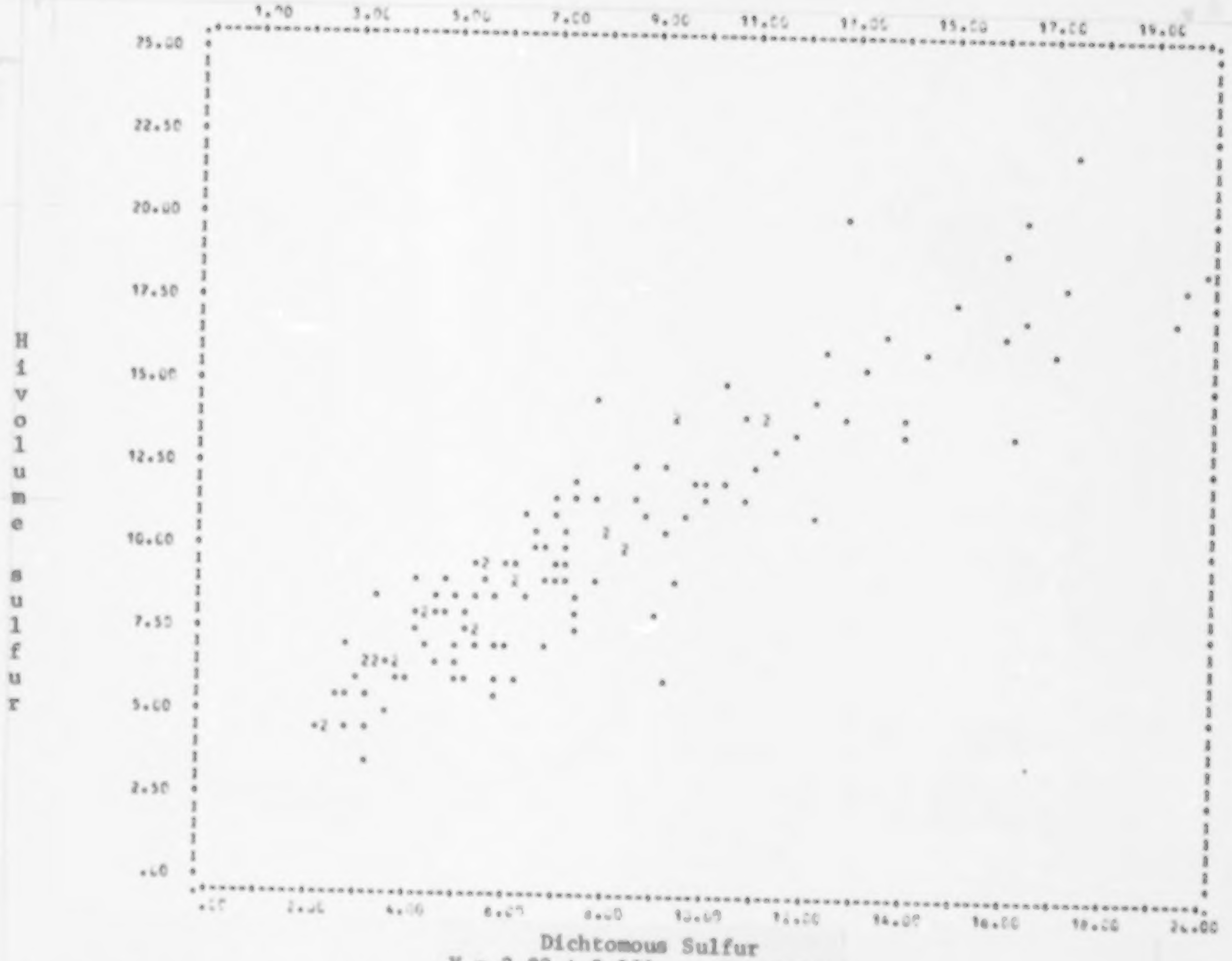
Y = 28.3 + 0.919X   R = 0.433

Figure E.10 Comparison of high volume and dichotomous sampler mass measurements at station 124.



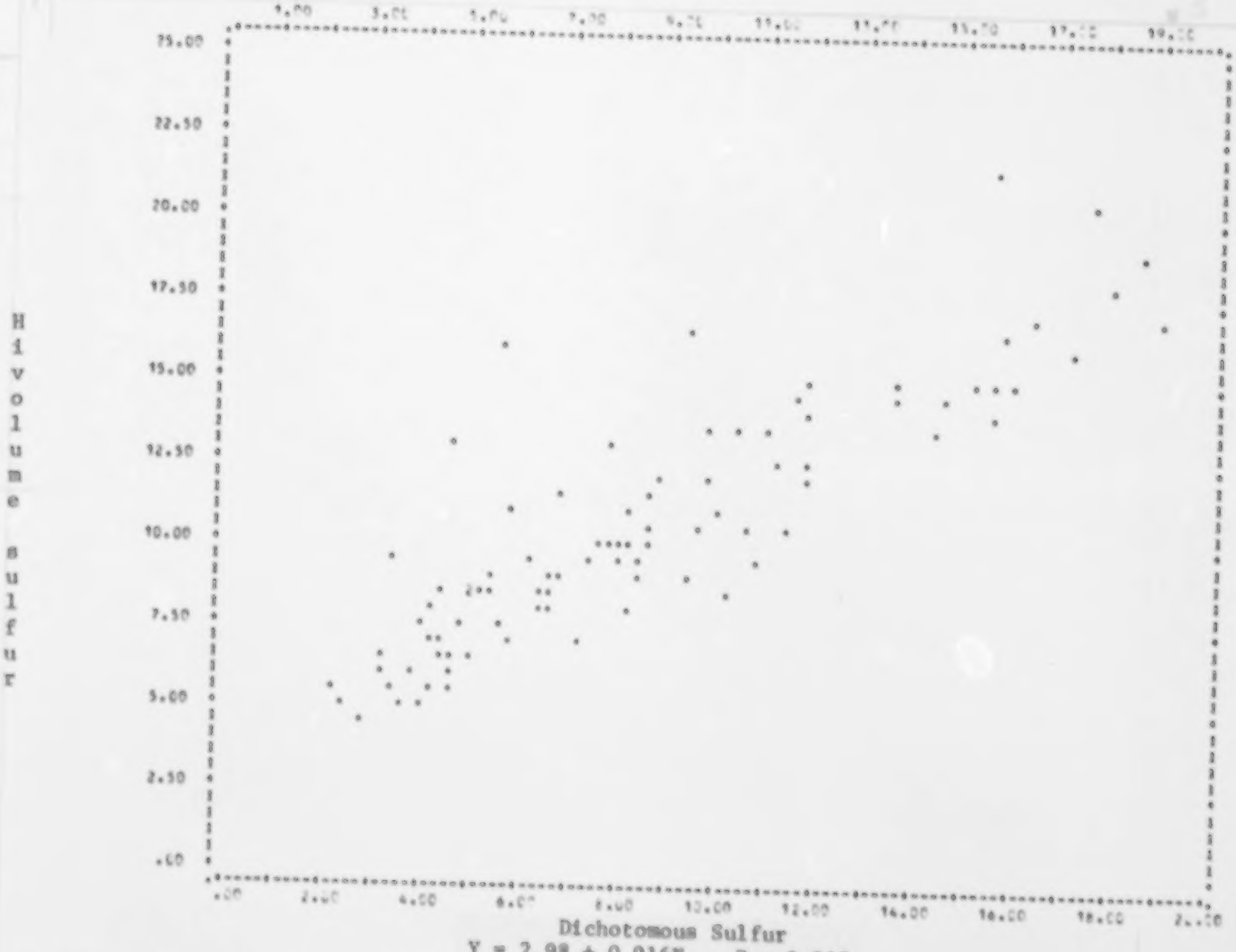
Y = 4.57 + 0.791X   R = 0.857

Figure E.11 Comparison of high volume and dichotomous sampler sulfur measurements at station 103.



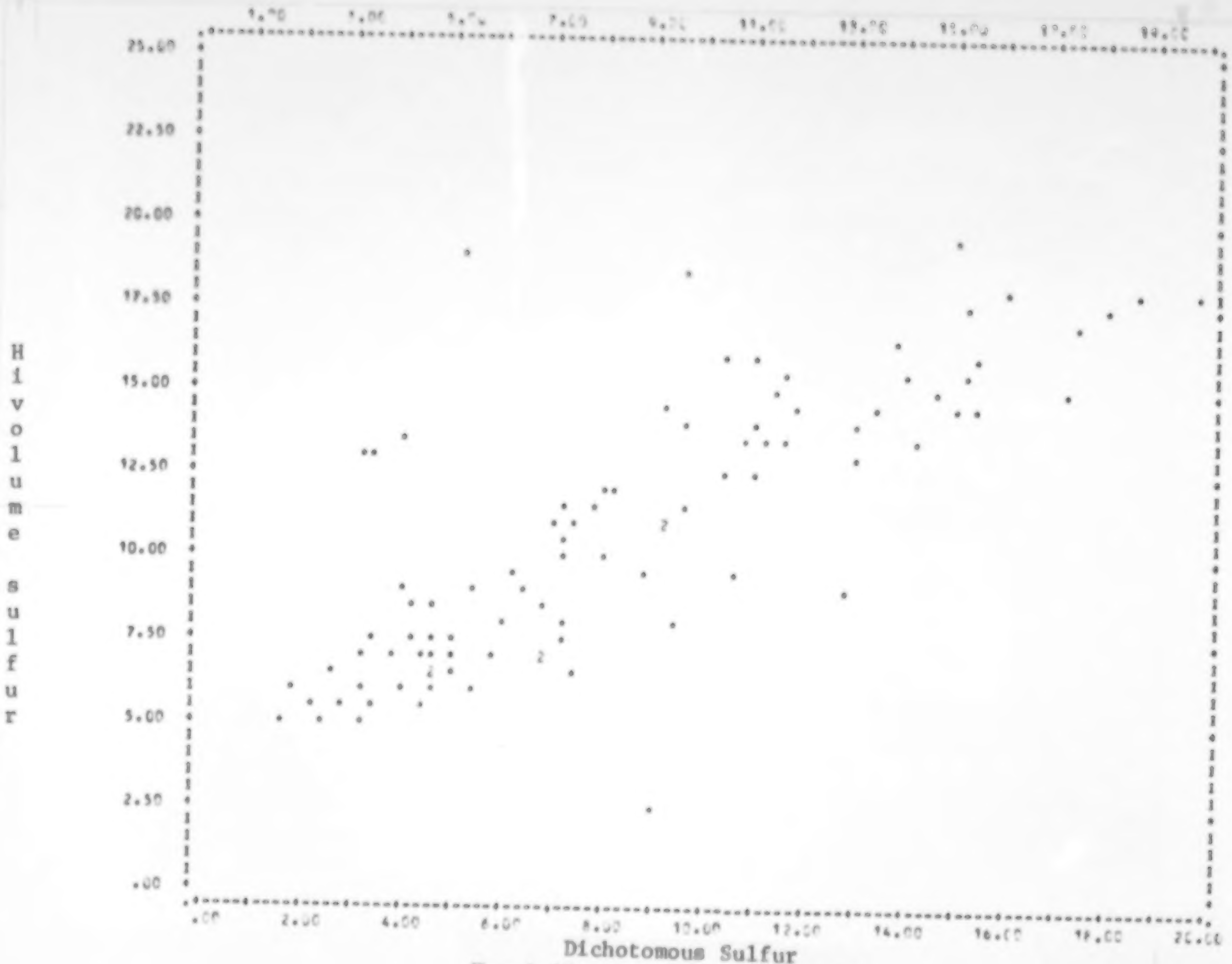
Y = 2.82 + 0.939   R = 0.964

Figure E.12 Comparison of high volume and dichotomous sampler sulfur measurements at station 105.



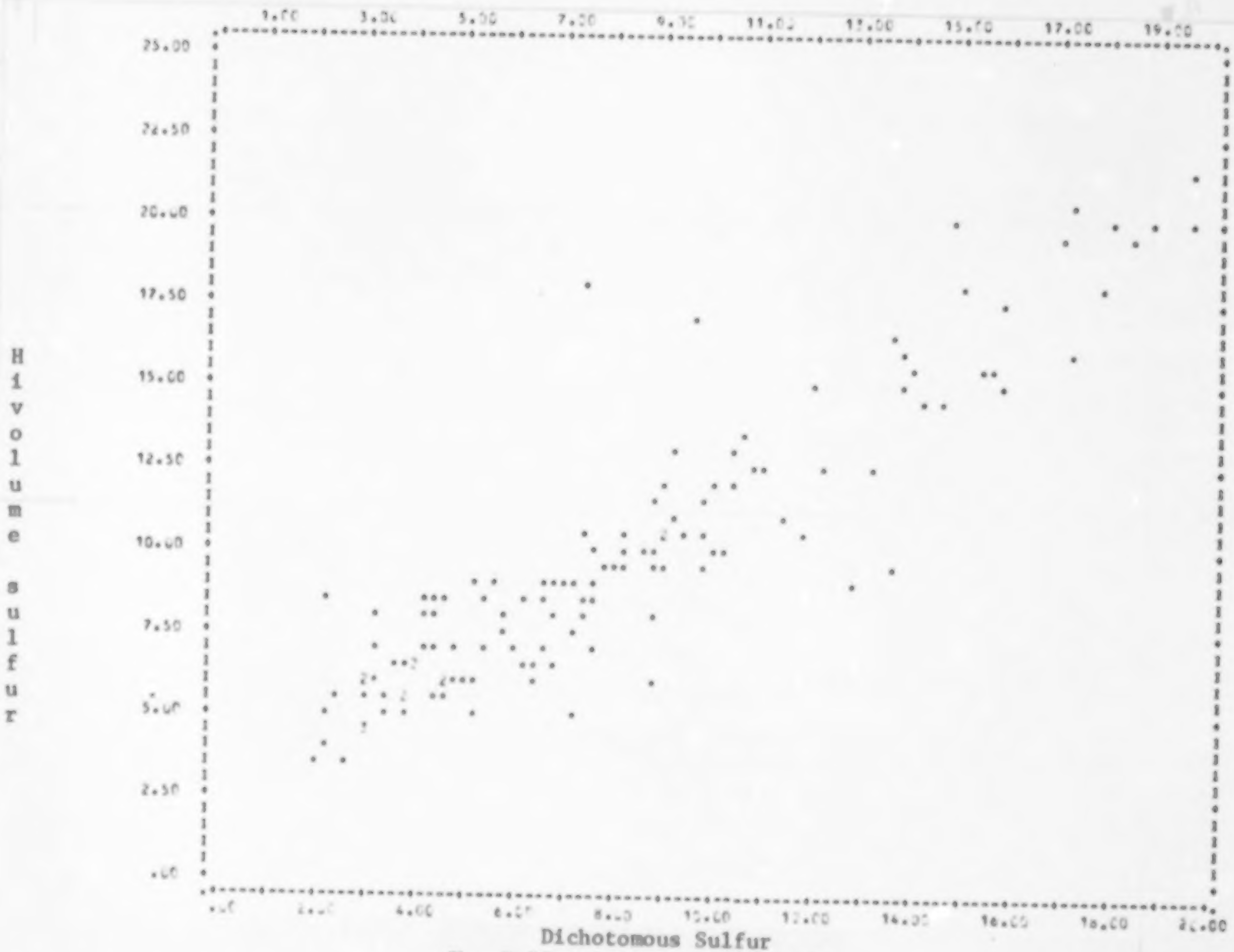
Y = 2.98 + 0.916X R = 0.937

Figure E.13 Comparison of high volume and dichotomous sampler sulfur measurements at station 106.



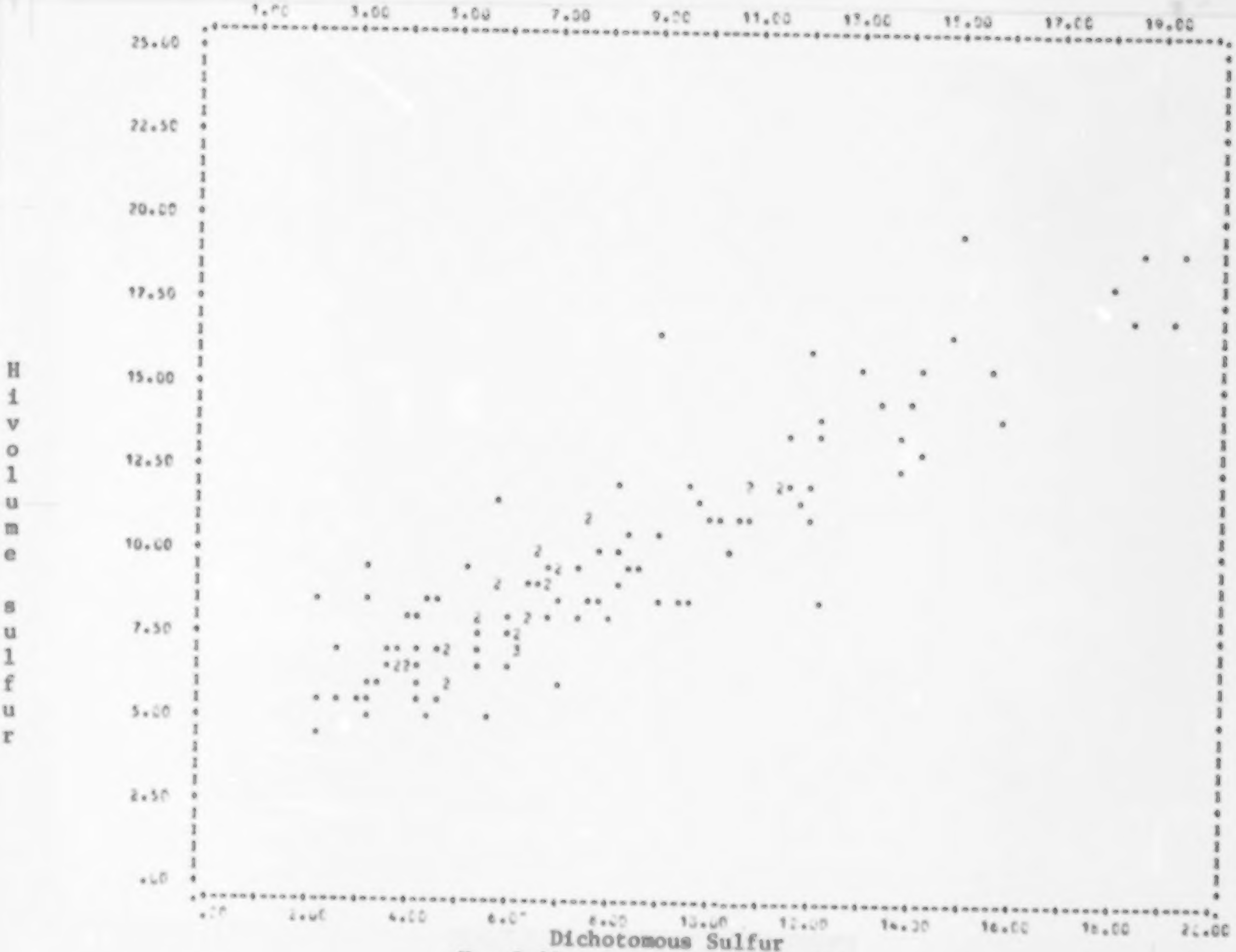
Y = 4.65 + 0.778X   R = 0.811

Figure E.14 Comparison of high volume and dichotomous sampler sulfur measurements at station 108.



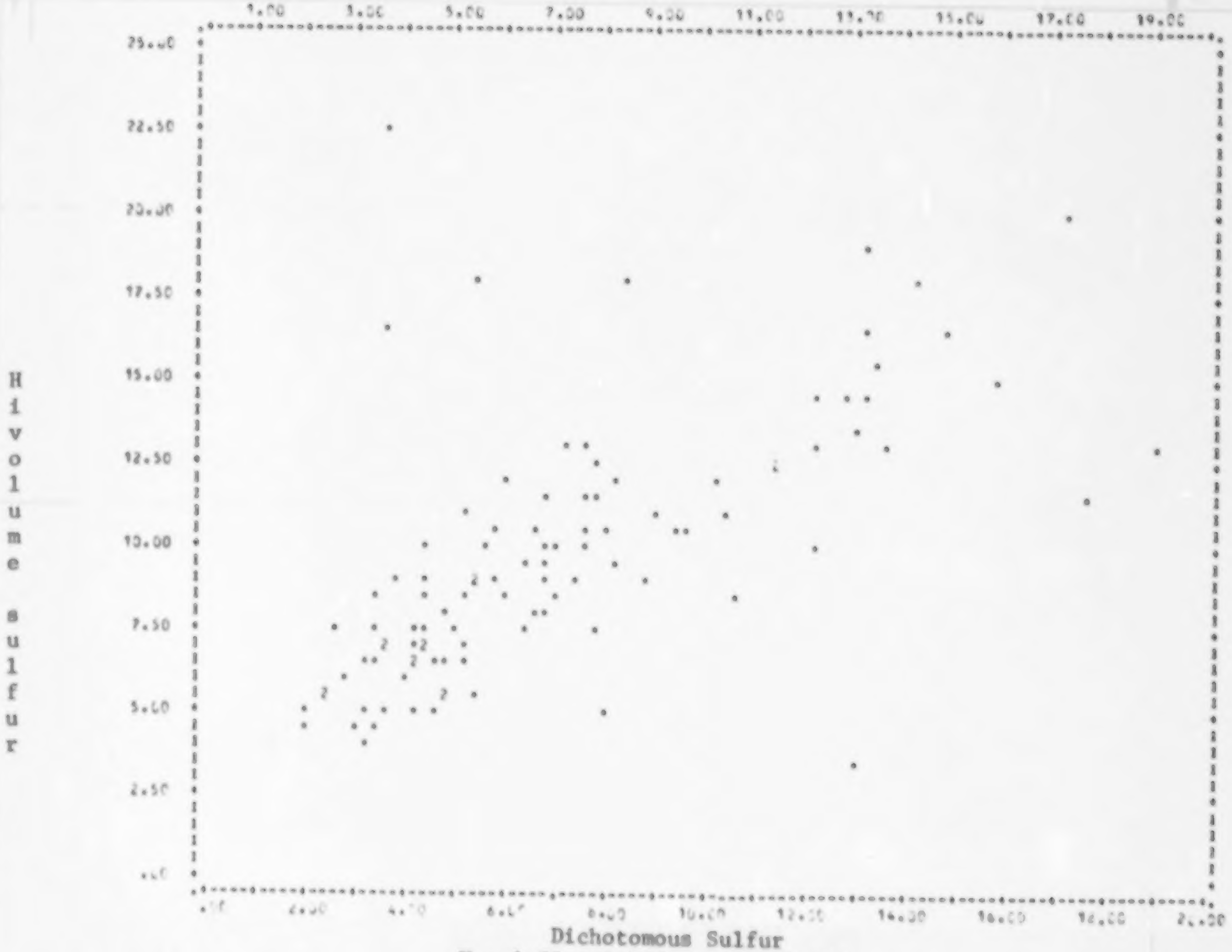
Y = 2.93 + 0.928X R = 0.818

Figure E.15 Comparison of high volume and dichotomous sampler sulfur measurements at station 112.



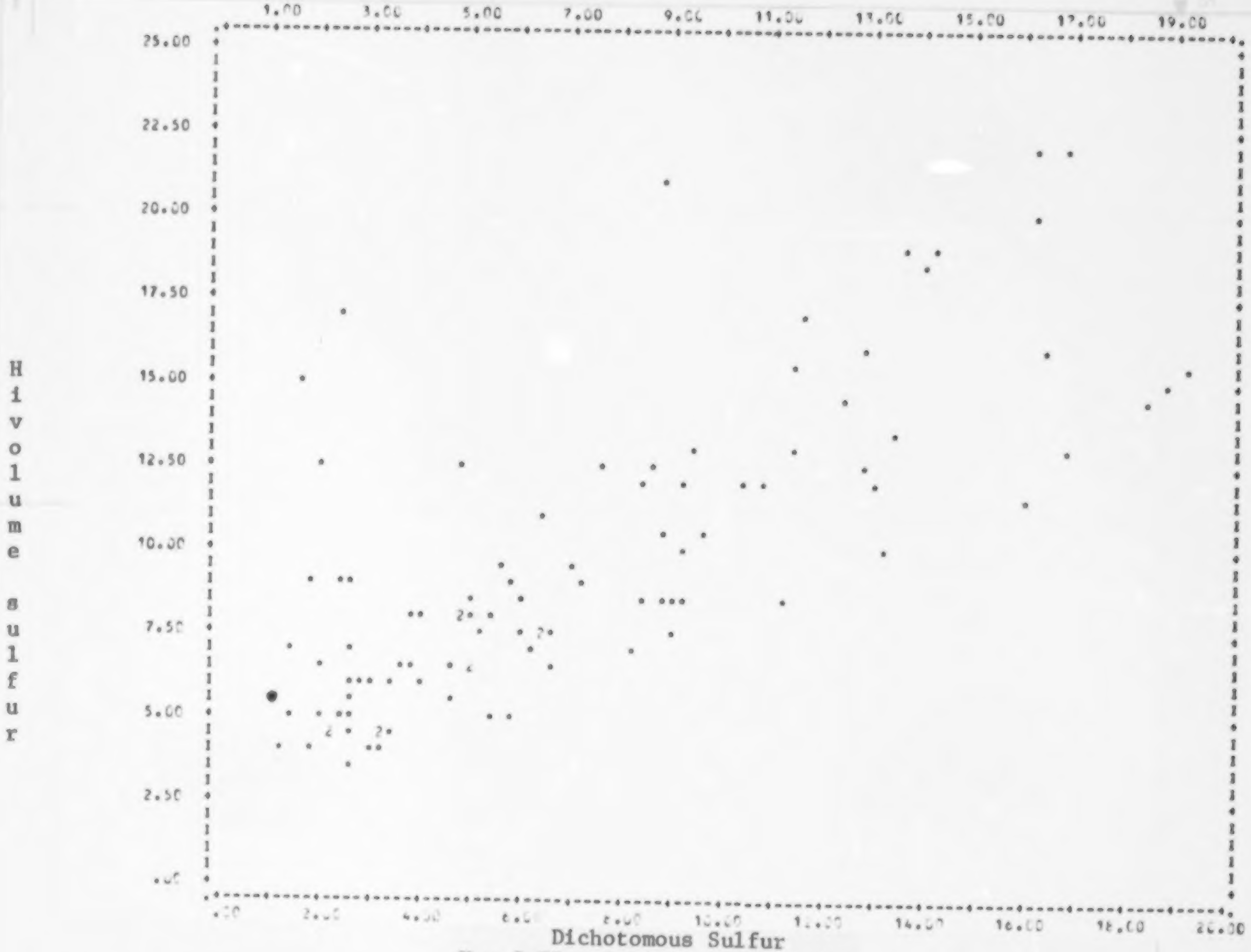
Y = 3.42 + 0.808X   R = 0.904

Figure E.16 Comparison of high volume and dichotomous sampler sulfur measurements at station 115.



Y = 4.73 + 0.706   R = 0.854

Figure E. 17 Comparison of high volume and dichotomous sampler sulfur measurements at station 118.



Y = 3.70 + 0.949X   R = 0.637

Figure E.18 Comparison of high volume and dichotomous sampler sulfur measurements at station 120.

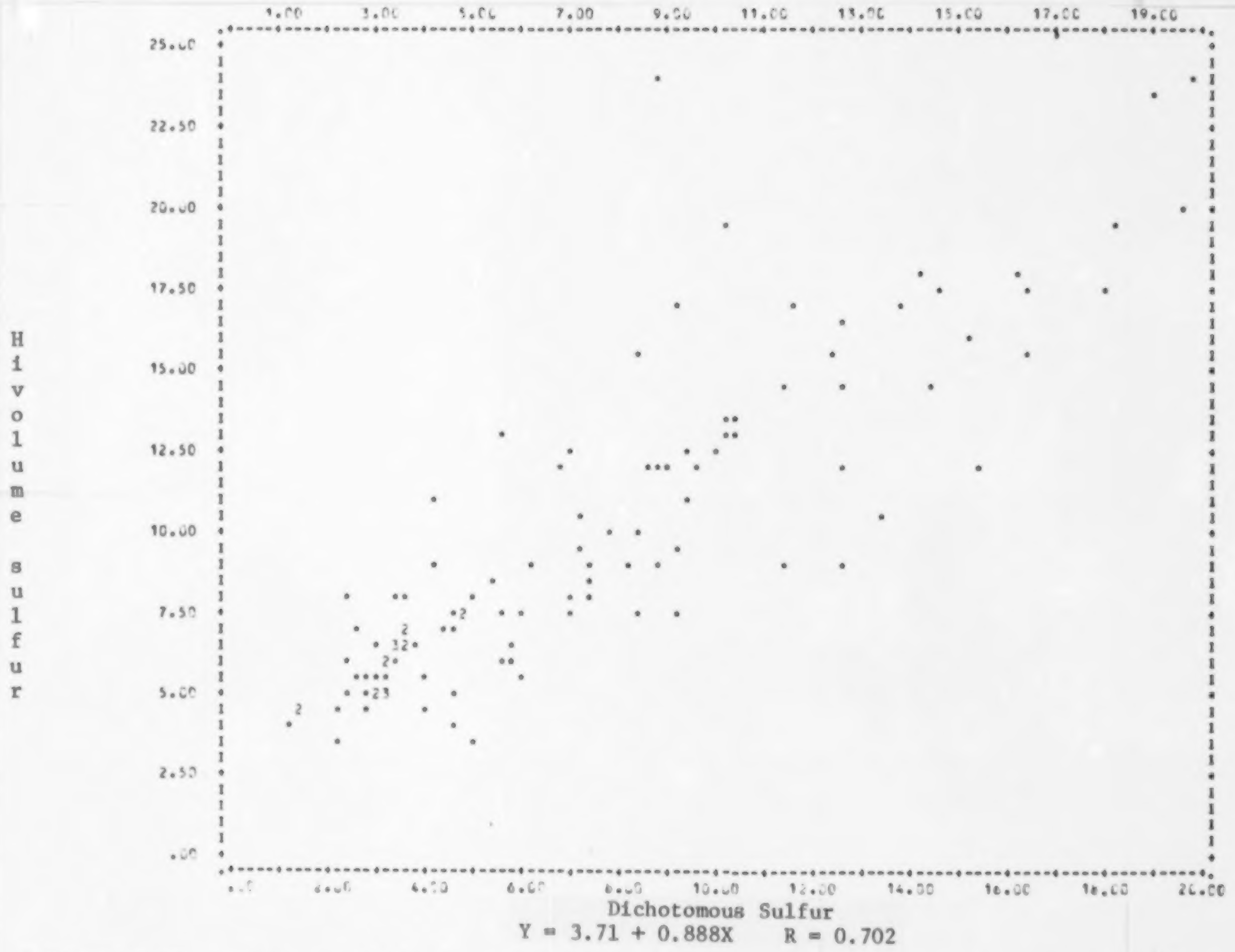
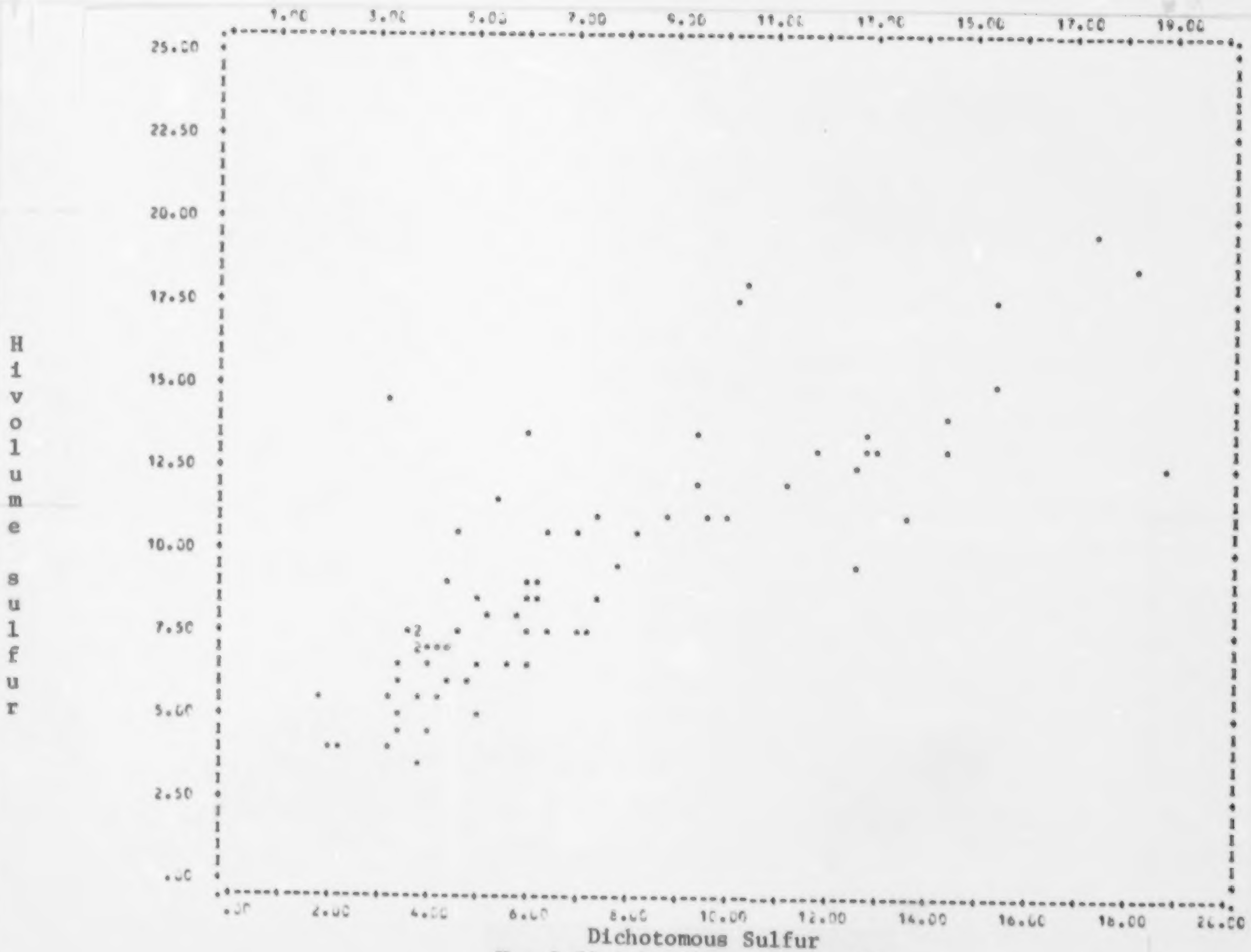


Figure E.19 Comparison of high volume and dichotomous sampler sulfur measurements at station 122.



Y = 3.62 + 0.864X R = 0.838

Figure E.20 Comparison of high volume and dichotomous sampler sulfur measurements at station 124.

APPENDIX F

DICHOTOMOUS FINE:TOTAL RATIOS FOR MASS, SULFUR, AND LEAD BY STATION

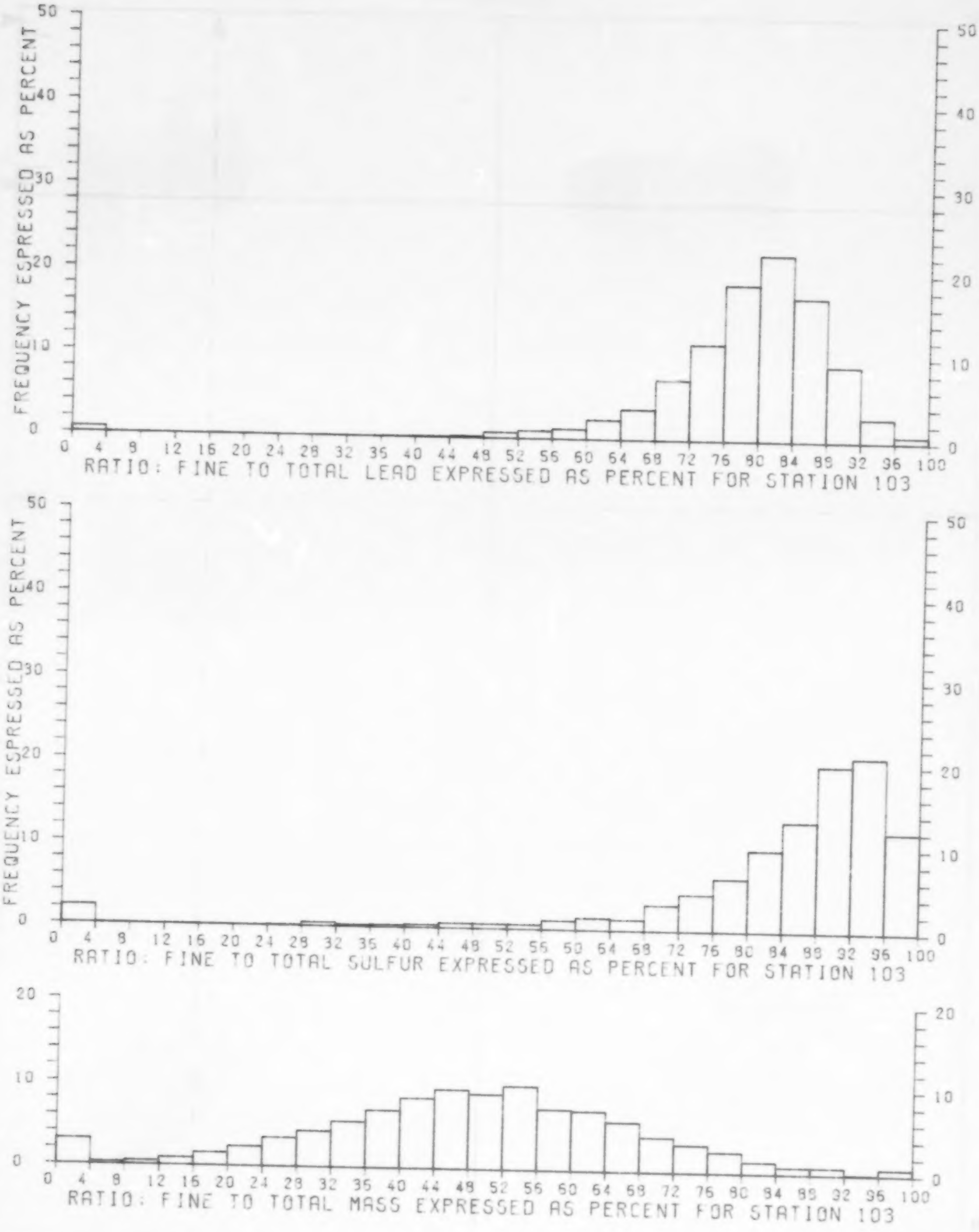


Figure F.1 Frequency distribution of fine:total ratio for selected elements.

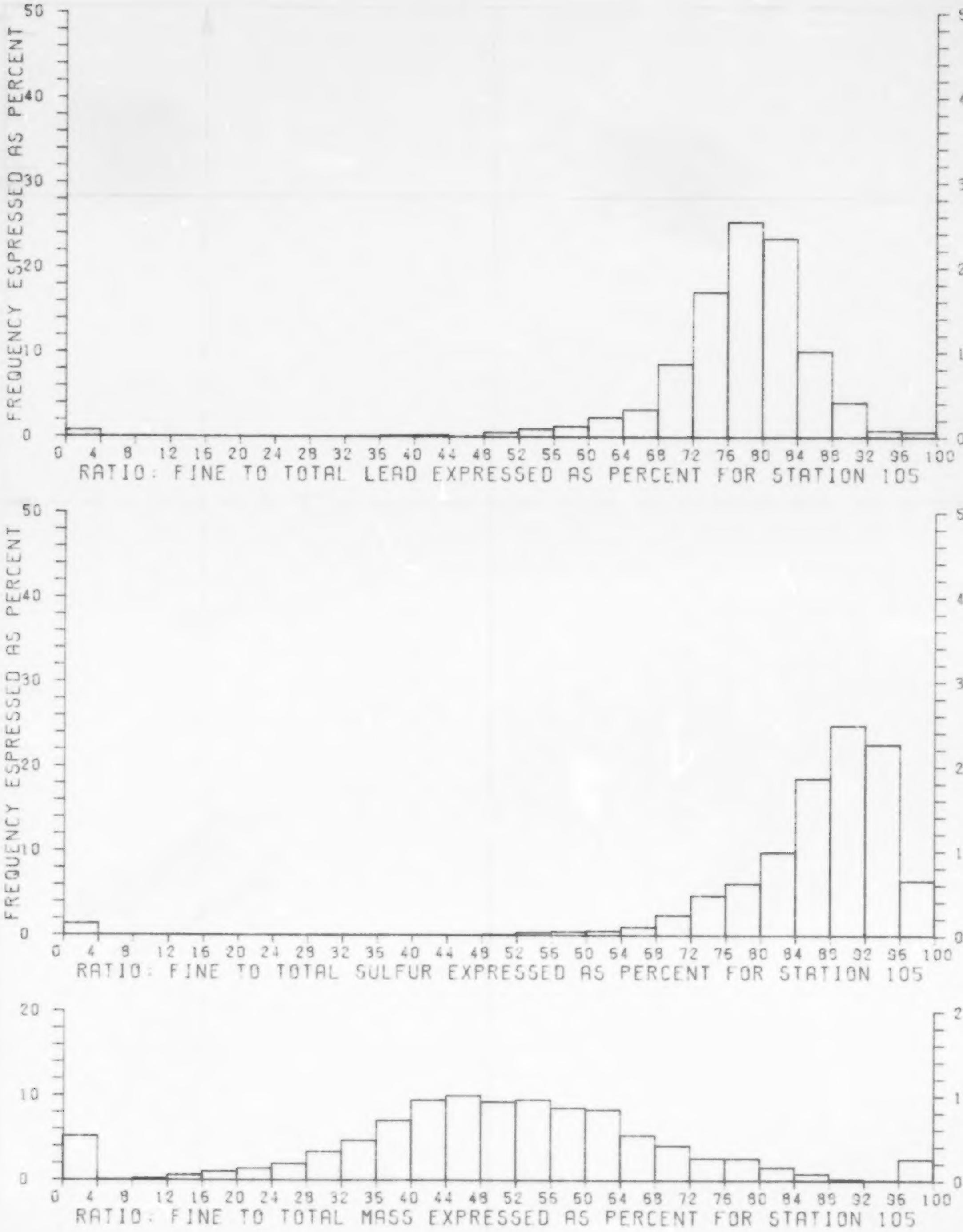


Figure F.2 Frequency distribution of fine:total ratio for selected elements.

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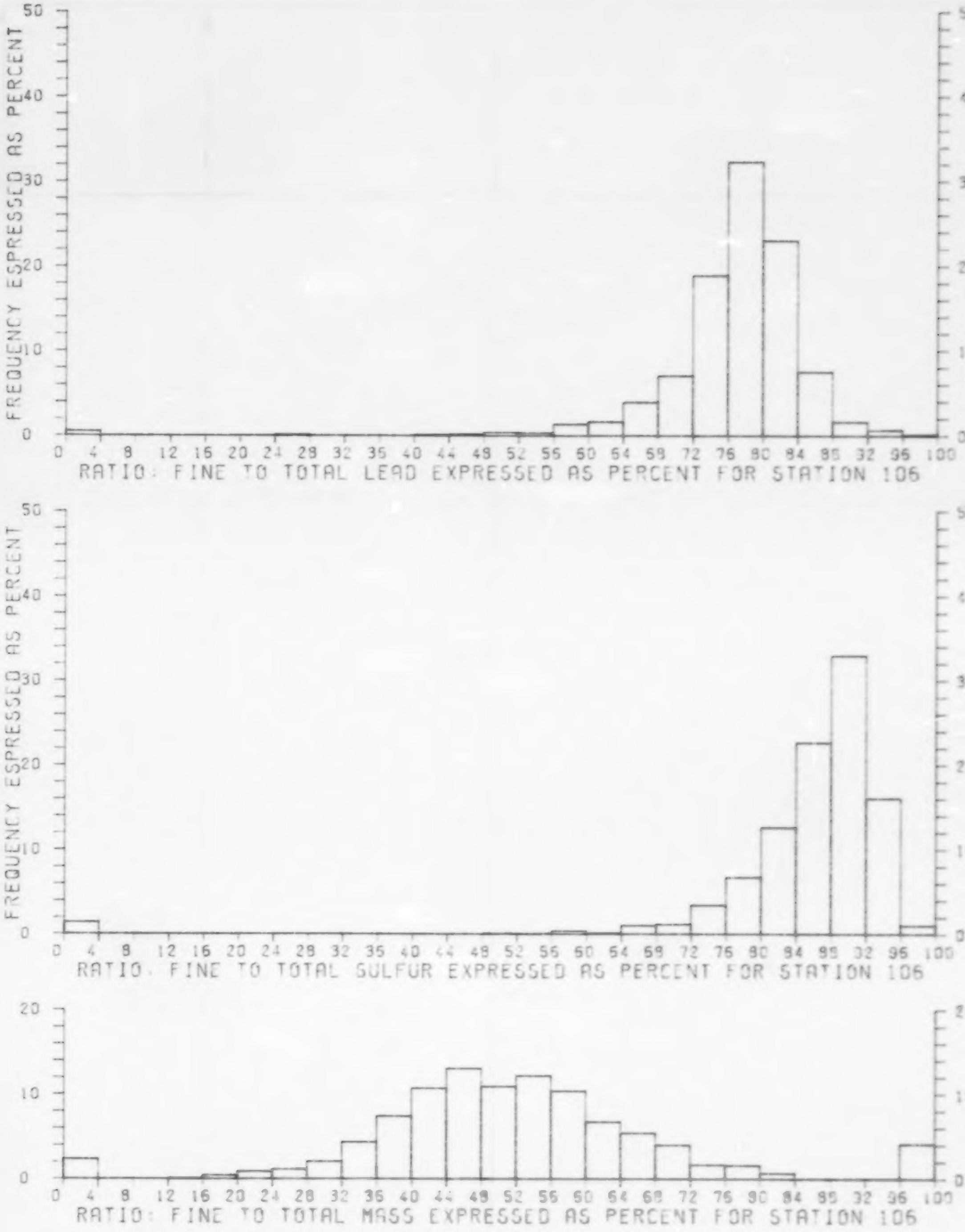

Figure F.3 Frequency distribution of fine:total ratio for selected elements.

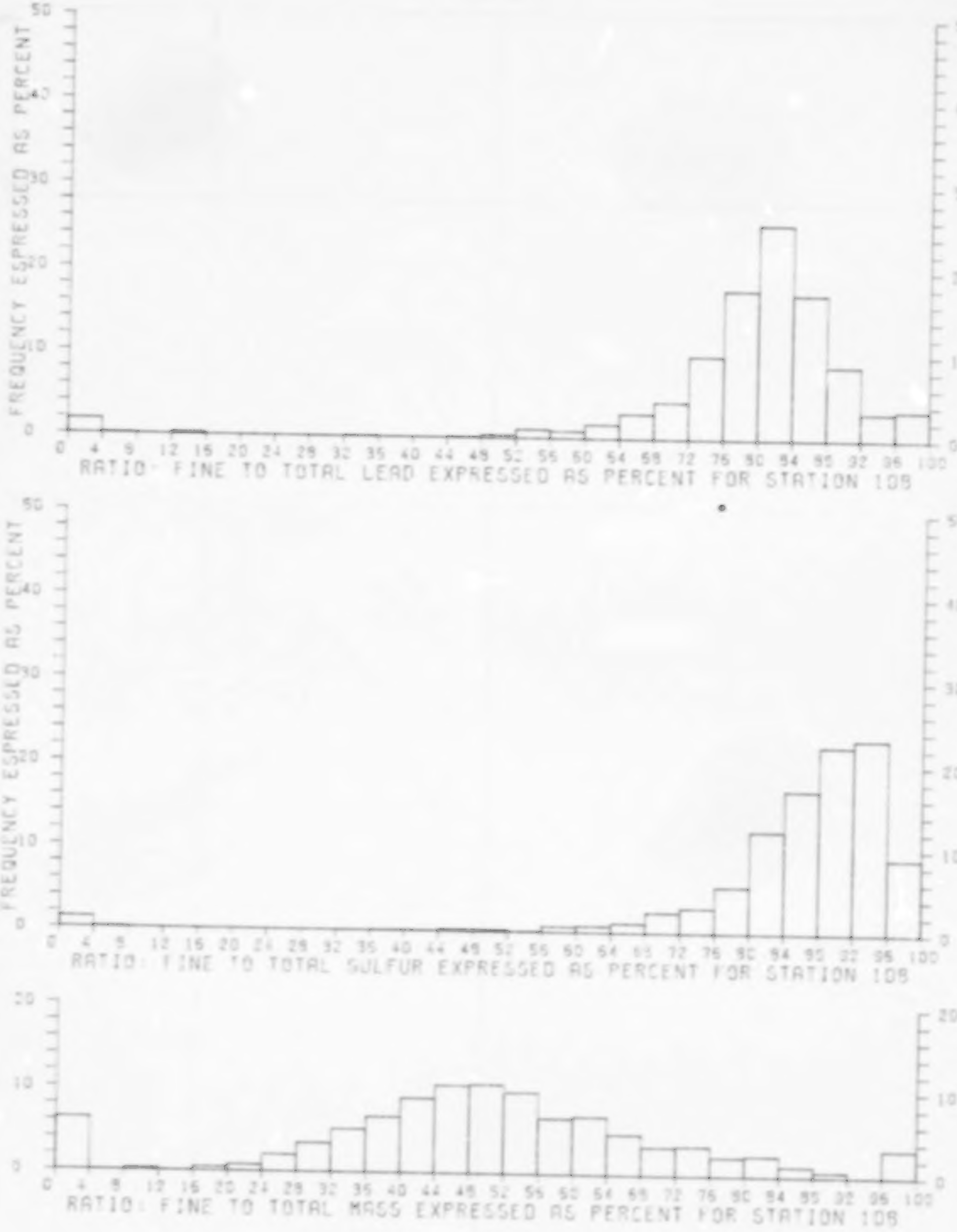

Figure F.4 Frequency distribution of fine:total ratio for selected elements.

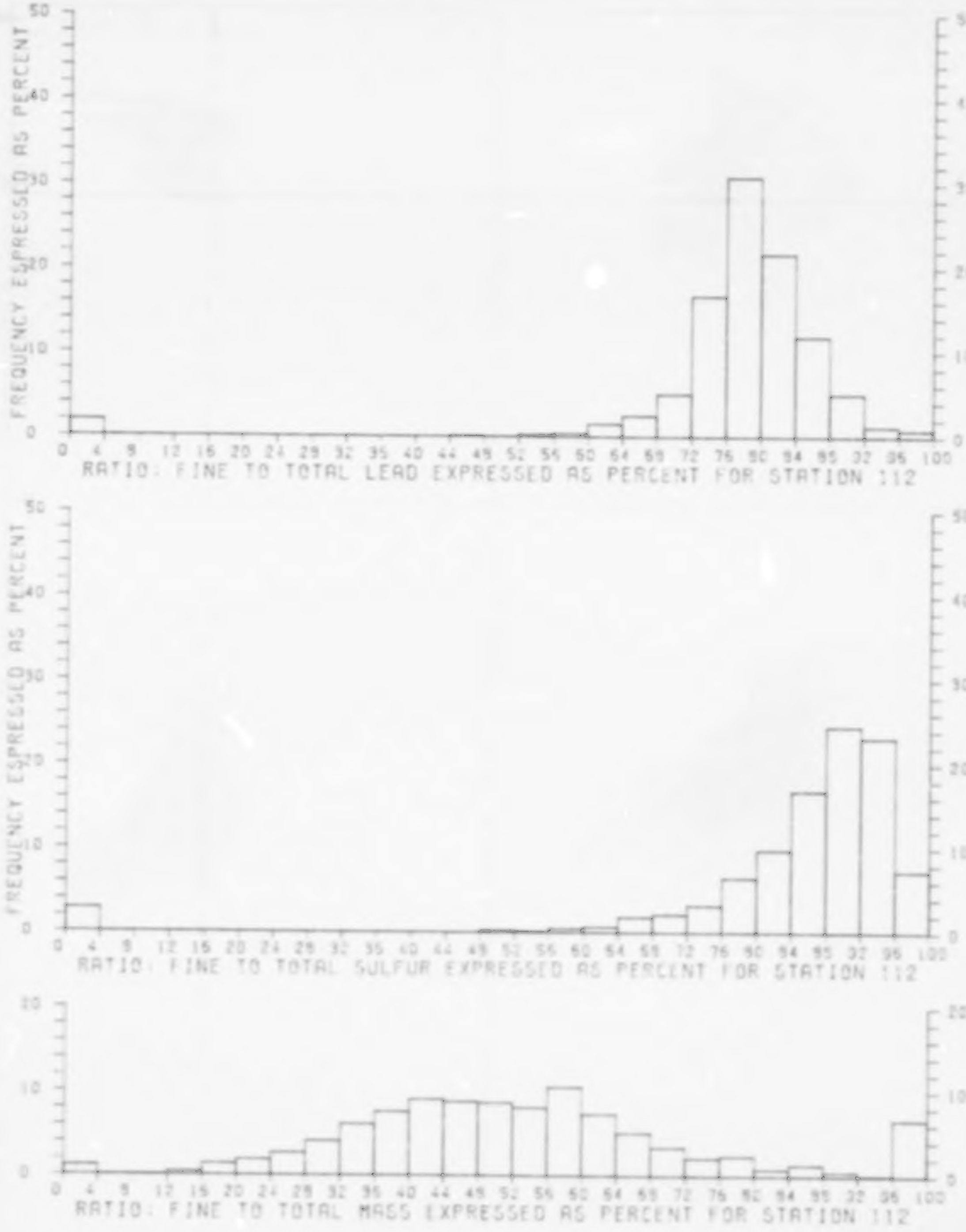

Figure F.5 Frequency distribution of fine:total ratio for selected elements.

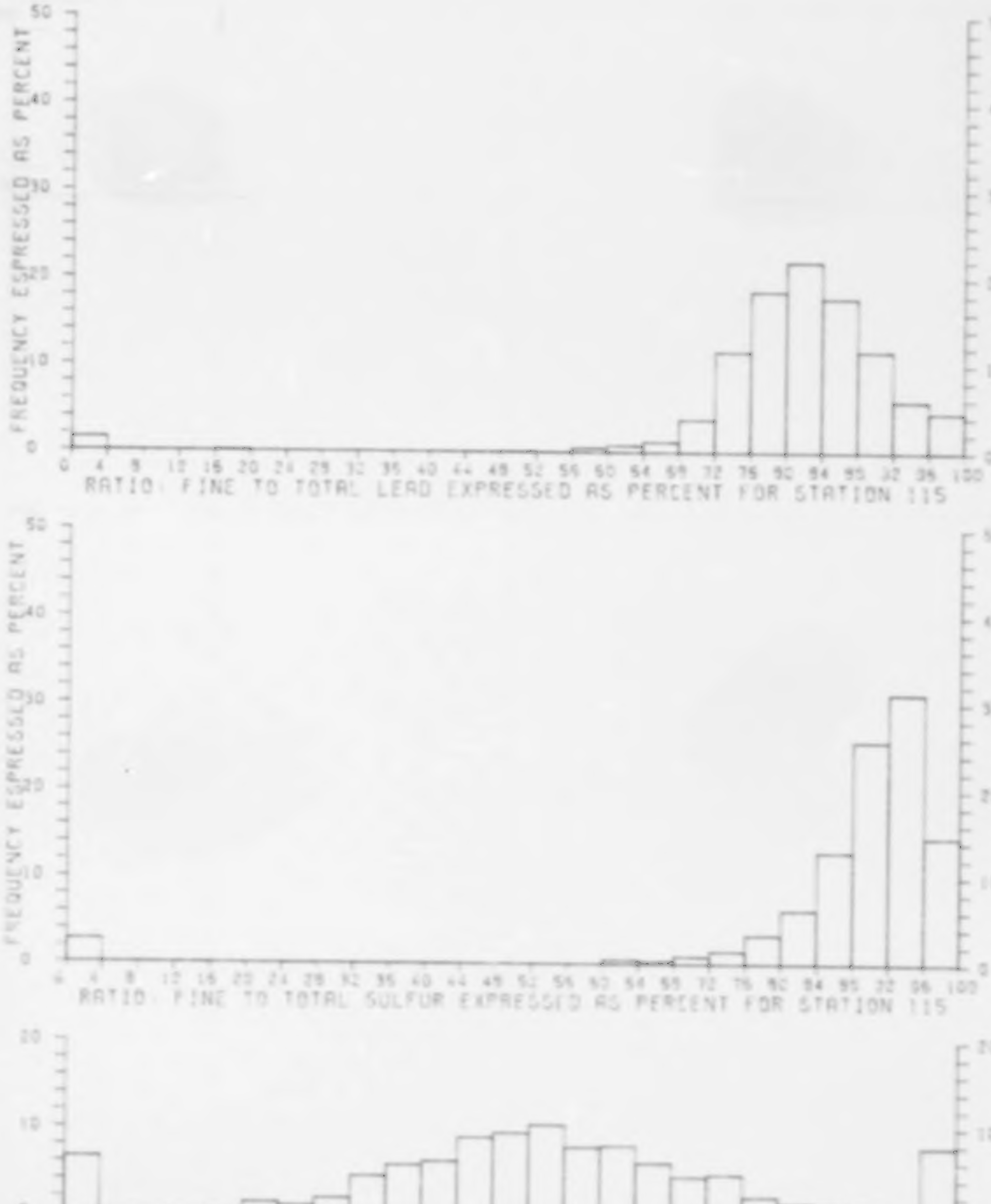

Figure F.6 Frequency distribution of fine:total ratio for selected elements.

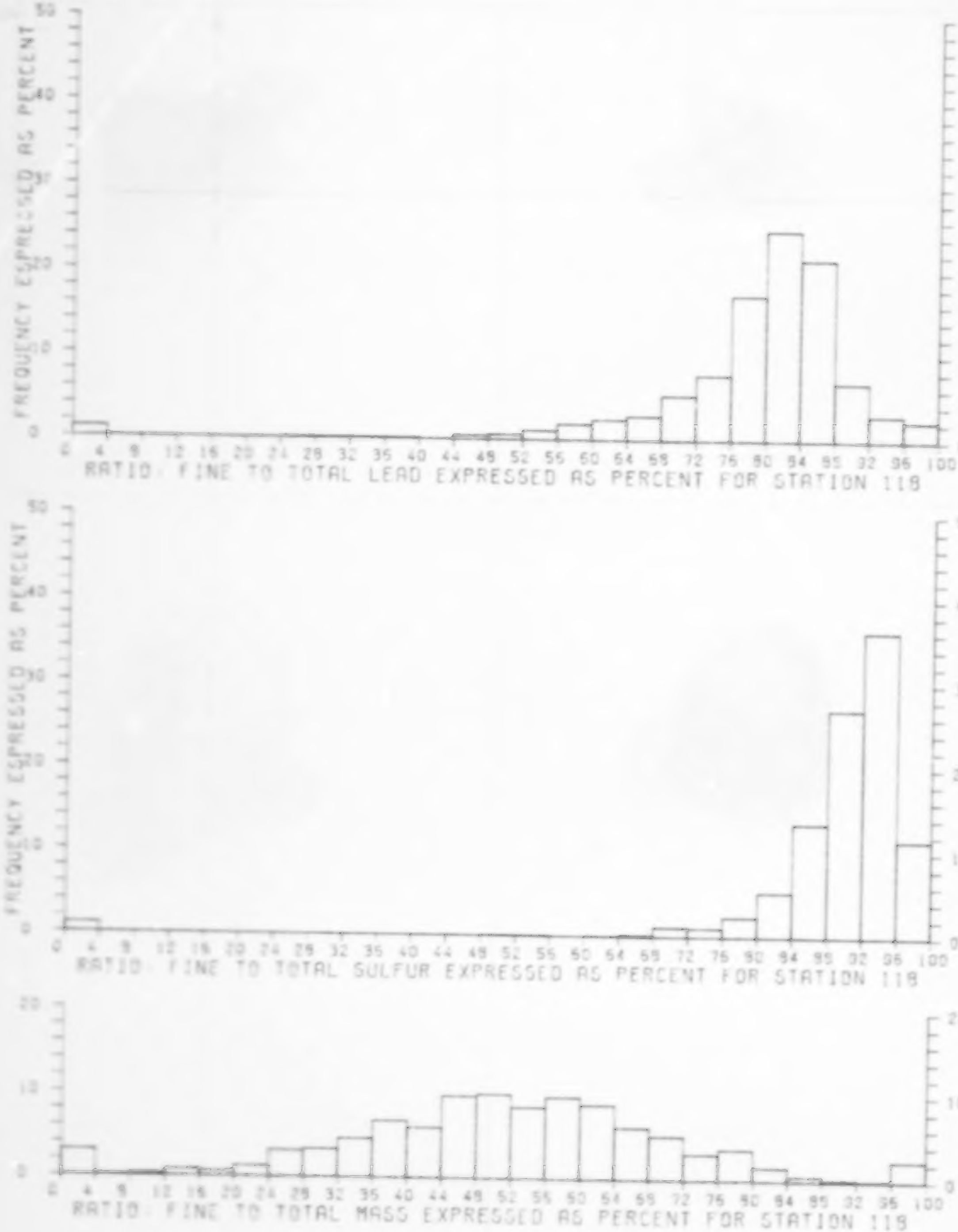

Figure F.7 Frequency distribution of fine:total ratio for selected elements.

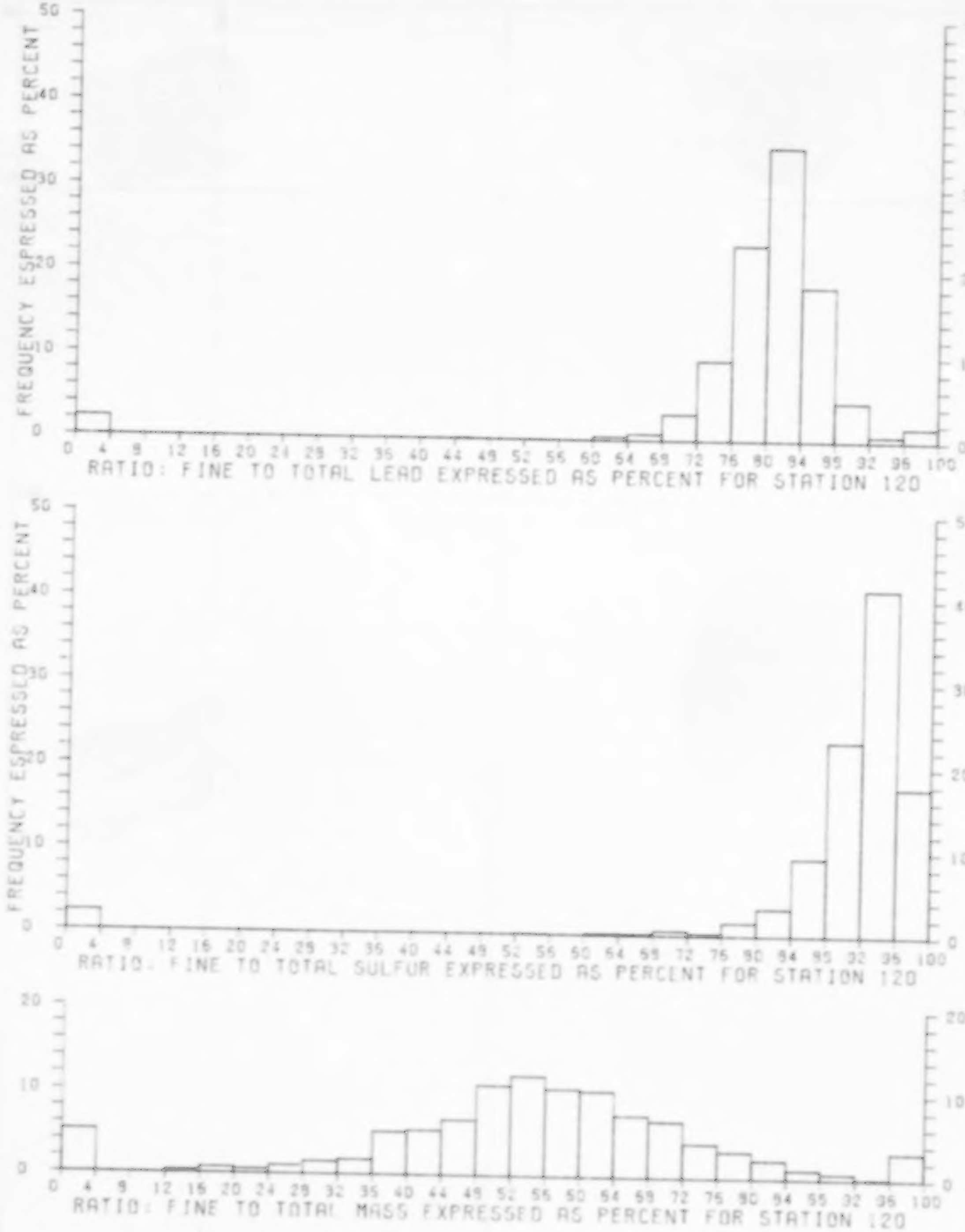

Figure F.8 Frequency distribution of fine:total ratio for selected elements.

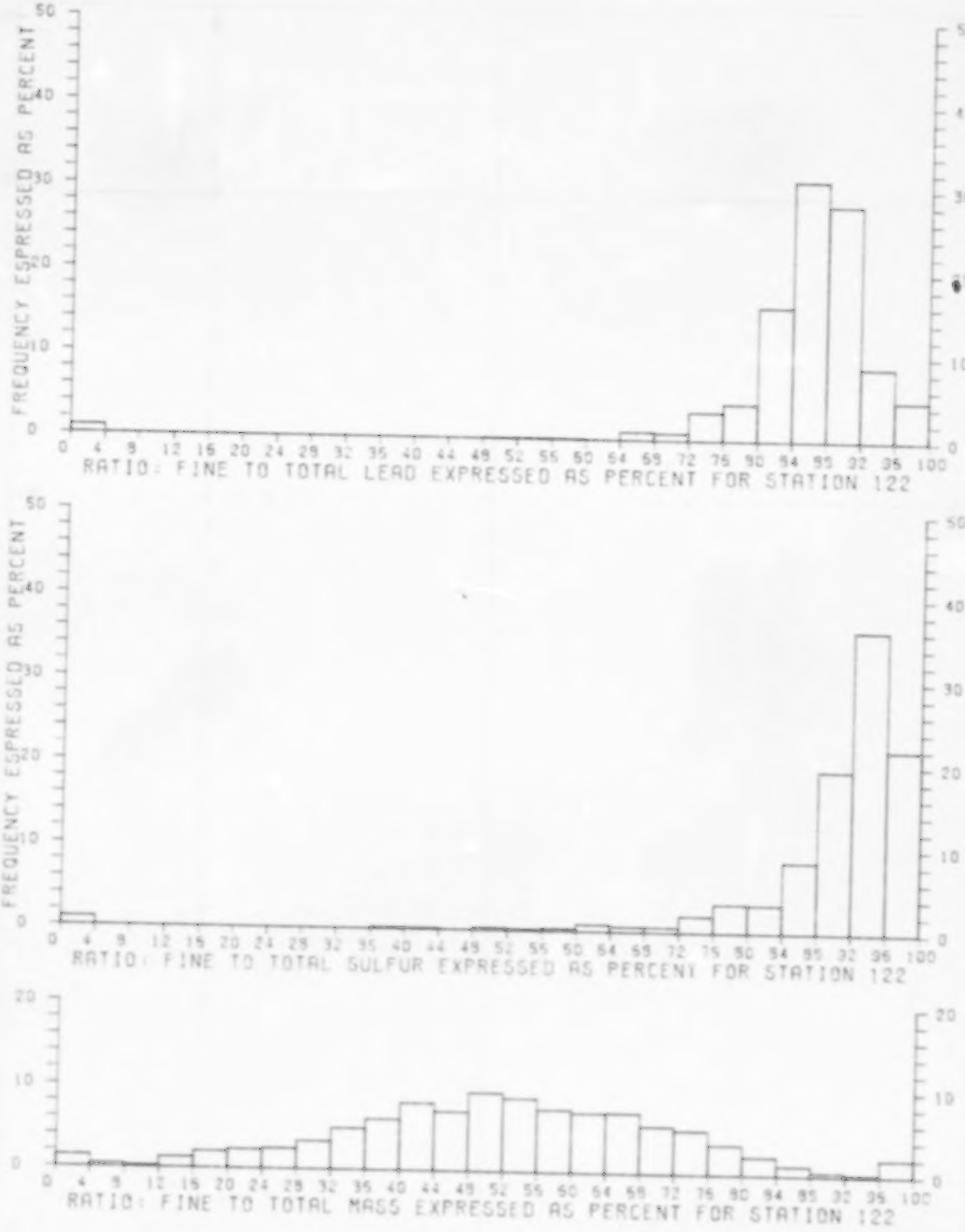

Figure F.9 Frequency distribution of fine:total ratio for selected elements.

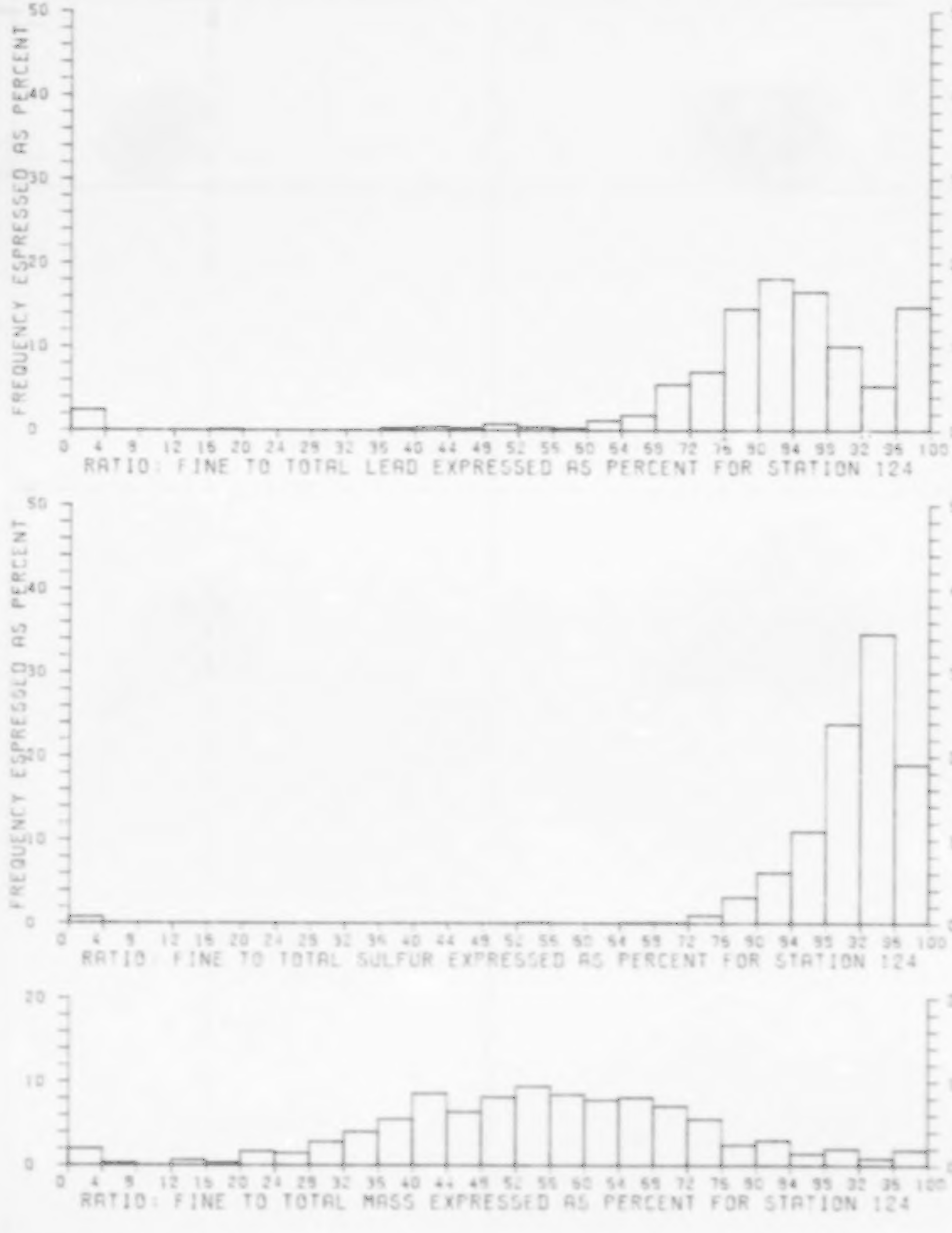

Figure F.10 Frequency distribution of fine:total ratio for selected elements.

TABLE F.1 MEANS AND STANDARD DEVIATIONS OF THE RATIOS OF FINE FRACTION TO TOTAL, FOR MASS, SULFUR, AND LEAD
STATION 103

		Mass			Sulfur			Lead		
Year	Qtr.	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#
1975	2	55	.64	.14	54	.91	.06	53	.83	.07
	3	498	.50	.16	471	.90	.08	496	.78	.08
	4	322	.59	.16	290	.88	.11	328	.81	.09
1976	1	303	.47	.16	295	.85	.13	298	.78	.11
	2	300	.47	.13	333	.82	.14	334	.77	.08
	3	262	.48	.15	269	.86	.12	269	.79	.06
	4	251	.45	.17	265	.80	.14	265	.80	.08
1977	1	217	.51	.16	227	.85	.12	228	.80	.09
	All	2201	.50	.16	2206	.86	.12	2273	.79	.09

TABLE F.2 MEANS AND STANDARD DEVIATIONS OF THE RATIOS OF FINE FRACTION TO TOTAL, FOR MASS, SULFUR, AND LEAD
STATION 105

		Mass			Sulfur			Lead		
Year	Qtr.	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#
1975	2	53	.55	.11	50	.91	.06	50	.76	.07
	3	494	.50	.15	470	.87	.09	496	.76	.09
	4	320	.54	.13	328	.88	.11	329	.78	.08
1976	1	283	.47	.16	321	.84	.07	324	.77	.08
	2	296	.47	.13	329	.88	.06	331	.76	.07
	3	257	.55	.13	291	.89	06	293	.78	.08
	4	227	.50	.15	234	.85	.10	235	.80	.07
1977	1	254	.55	.16	281	.88	.07	283	.79	.08
	All	2184	.51	.15	2306	.87	.08	2343	.77	.08

* $\bar{\rho}$ is the average of the ratios, ρ, of fine fraction measurement to total measurement (fine plus coarse fraction).

# α is the standard deviation of ρ.

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TABLE F.3 MEANS AND STANDARD DEVIATIONS OF THE RATIOS OF FINE FRACTION TO TOTAL, FOR MASS, SULFUR, AND LEAD
STATION 106

		Mass			Sulfur			Lead		
Year	Qtr.	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#
1975	2	49	.15	.12	49	.86	.06	49	.79	.04
	3	211	.52	.13	241	.87	.07	242	.78	.06
	4	97	.52	.13	104	.81	.08	104	.79	.05
1976	1	169	.50	.11	171	.88	.05	172	.76	.08
	2	155	.46	.10	175	.88	.05	174	.75	.08
	3	95	.54	.10	102	.89	.04	104	.78	.05
	4	0	---		0	---		0	---	
1977	1	0	---		0	---		0	---	
	All	776	.51	.12	842	.87	.06	843	.77	.07

TABLE F.4 MEANS AND STANDARD DEVIATIONS OF THE RATIOS OF FINE FRACTION TO TOTAL, FOR MASS, SULFUR, AND LEAD
STATION 108

108

		Mass			Sulfur			Lead		
Year	Qtr.	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#
1975	2	32	.68	.13	32	.93	.04	32	.91	.06
	3	184	.54	.15	173	.88	.10	177	.81	.08
	4	78	.50	.13	79	.76	.10	79	.78	.10
1976	1	137	.51	.13	168	.88	.07	170	.76	.12
	2	163	.46	.13	164	.89	.06	164	.79	.07
	3	135	.53	.15	151	.91	.09	154	.81	.11
	4	85	.54	.13	107	.87	.08	107	.83	.06
1977	1	34	.61	.19	39	.89	.05	39	.83	.05
	All	848	.52	.15	913	.88	.09	922	.80	.09

* $\bar{\rho}$ is the average of the ratios, ρ, of fine fraction measurement to total measurement (fine plus coarse fraction).

# α is the standard deviation of ρ.

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TABLE F.5 MEANS AND STANDARD DEVIATIONS OF THE RATIOS OF FINE FRACTION TO TOTAL, FOR MASS, SULFUR, AND LEAD
STATION 112

		Mass			Sulfur			Lead		
Year	Qtr.	No. of cases	$\bar{\rho}^*$	$\alpha^\#$	No. of cases	$\bar{\rho}^*$	$\alpha^\#$	No. of cases	$\bar{\rho}^*$	$\alpha^\#$
1975	2	43	.49	.12	38	.83	.09	38	.77	.03
	3	322	.45	.16	313	.89	.09	368	.77	.06
	4	111	.52	.12	113	.80	.08	113	.79	.06
1976	1	131	.47	.13	176	.88	.06	178	.76	.06
	2	165	.43	.13	162	.88	.07	165	.77	.06
	3	137	.49	.14	148	.88	.07	148	.79	.05
	4	134	.61	.17	145	.90	.08	146	.85	.06
1977	1	73	.61	.13	74	.91	.04	74	.82	.05
	All	1116	.49	.16	1169	.88	.08	1230	.79	.06

TABLE F.6 MEANS AND STANDARD DEVIATIONS OF THE RATIOS OF FINE FRACTION TO TOTAL, FOR MASS, SULFUR, AND LEAD
STATION 115

		Mass			Sulfur			Lead		
Year	Qtr.	No. of cases	$\bar{\rho}^*$	$\alpha^\#$	No. of cases	$\bar{\rho}^*$	$\alpha^\#$	No. of cases	$\bar{\rho}^*$	$\alpha^\#$
1975	2	12	.68	.06	13	.93	.13	13	.85	.02
	3	206	.53	.13	210	.90	.06	214	.79	.06
	4	138	.57	.15	139	.84	.07	139	.81	.05
1976	1	137	.54	.13	161	.91	.05	162	.81	.09
	2	141	.49	.12	150	.91	.04	150	.78	.06
	3	92	.51	.14	148	.94	.05	205	.88	.08
	4	106	.52	.15	146	.91	.06	147	.86	.06
1977	1	45	.72	.10	47	.93	.03	48	.89	.05
	All	877	.54	.14	1014	.90	.06	1078	.83	.08

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* $\bar{\rho}$ is the average of the ratios, ρ, of fine fraction measurement to total measurement (fine plus coarse fraction).

# α is the standard deviation of ρ.

TABLE F.7 MEANS AND STANDARD DEVIATION OF THE RATIOS OF FINE FRACTION TO TOTAL, FOR MASS, SULFUR, AND LEAD STATION 118

		Mass			Sulfur			Lead		
Year	Qtr.	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#
1975	2	46	.49	.16	45	.90	.04	45	.79	.09
	3	114	.50	.16	143	.91	.06	140	.81	.08
	4	60	.53	.17	58	.86	.10	58	.80	.12
1976	1	151	.51	.14	153	.92	.05	153	.77	.11
	2	159	.52	.14	158	.93	.04	161	.80	.10
	3	129	.48	.17	131	.91	.04	131	.80	.07
	4	139	.53	.15	149	.89	.06	149	.80	.09
1977	1	63	.64	.13	64	.90	.05	64	.81	.10
	All	861	.52	.15	901	.91	.06	901	.80	.09

TABLE F.8 MEANS AND STANDARD DEVIATION OF THE RATIOS OF FINE FRACTION TO TOTAL, FOR MASS, SULFUR, AND LEAD STATION 120

		Mass			Sulfur			Lead		
Year	Qtr.	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#	No. of cases	$\bar{\rho}$*	α#
1975	2	13	.59	.07	13	.91	.03	13	.79	.04
	3	238	.55	.14	235	.93	.04	241	.81	.05
	4	164	.60	.12	164	.94	.04	165	.81	.05
1976	1	126	.55	.12	112	.92	.05	117	.80	.07
	2	163	.54	.13	172	.93	.04	172	.80	.04
	3	101	.55	.16	144	.90	.06	145	.80	.04
	4	119	.55	.15	133	.89	.07	133	.82	.04
1977	1	59	.64	.16	55	.91	.04	55	.84	.04
	All	983	.56	.14	1028	.92	.05	1041	.81	.05

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* $\bar{\rho}$ is the average of the ratios, ρ, of fine fraction measurement to total measurement (fine plus coarse fraction).

# α is the standard deviation of ρ.

TABLE F.9 MEANS AND STANDARD DEVIATION OF THE RATIOS OF FINE FRACTION TO TOTAL, FOR MASS, SULFUR, AND LEAD STATION 122

		Mass			Sulfur			Lead		
Year	Qtr.	No. of cases	$\bar{\rho}^*$	$\alpha^\#$	No. of cases	$\bar{\rho}^*$	$\alpha^\#$	No. of cases	$\bar{\rho}^*$	$\alpha^\#$
1975	2	43	.58	.17	43	.93	.03	43	.88	.04
	3	218	.51	.17	211	.92	.06	197	.88	.06
	4	88	.52	.14	89	.79	.12	90	.84	.04
1976	1	143	.55	.17	137	.92	.05	144	.85	.07
	2	159	.48	.15	162	.92	.05	162	.85	.05
	3	102	.53	.20	108	.94	.06	118	.87	.07
	4	109	.50	.19	114	.89	.12	116	.86	.06
1977	1	29	.65	.14	30	.94	.04	30	.90	.03
	All	891	.52	.17	894	.91	.08	900	.87	.06

TABLE F.10 MEANS AND STANDARD DEVIATION OF THE RATIOS OF FINE FRACTION TO TOTAL, FOR MASS, SULFUR, AND LEAD STATION 124

		Mass			Sulfur			Lead		
Year	Qtr.	No. of cases	$\bar{\rho}^*$	$\alpha^\#$	No. of cases	$\bar{\rho}^*$	$\alpha^\#$	No. of cases	$\bar{\rho}^*$	$\alpha^\#$
1975	2	35	.47	.11	36	.90	.03	36	.82	.06
	3	191	.54	.15	194	.90	.06	188	.84	.08
	4	105	.62	.12	105	.90	.06	105	.83	.08
1976	1	162	.51	.14	162	.90	.05	159	.77	.13
	2	145	.55	.21	130	.93	.05	114	.84	.10
	3	68	.71	.12	55	.95	.03	49	.88	.09
	4	0	---		0	---		0	---	
177	1	0	---		0	---		0	---	
	All	706	.56	.17	682	.91	.06	651	.82±	.10

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* $\bar{\rho}$ is the average of the ratios, ρ, of fine fraction measurement to total measurement (fine plus coarse fraction).

# α is the standard deviation of ρ.

APPENDIX G

DESCRIPTIVE STATISTICS FOR BOTH FRACTIONS OF SELECTED ELEMENTS; CORRELATIONS BETWEEN FRACTIONS BY STATION

TABLE G.1 RELATIONSHIPS BETWEEN FINE AND COARSE FRACTIONS FOR MASS AND 23 ELEMENTS (STATION 103)

	Fine fraction					Fine-coarse correlation			Coarse fraction				
Elmt.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*	No. of Cases	Coeff.	Sig.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*
MS	2227	161.9	1.000	30.07	19.83	2201	.486	.000	2262	194.4	1.500	31.29	21.78
P	1603	1.24	0.000	0.075	0.129	1575	.296	.000	2206	17.06	0.600	0.331	0.966
S	2251	22.05	0.150	3.317	2.822	2206	.142	.000	2219	18.73	1.600	0.501	0.857
Cl	1872	5.76	0.400	0.288	0.375	1485	.337	.000	1662	10.45	1.900	0.471	0.708
Ti	1429	0.89	0.100	0.031	0.055	1403	.844	.000	2013	5.92	0.200	0.143	0.247
Va	1315	0.06	0.100	0.008	0.007	923	.249	.000	1314	0.10	0.100	0.010	0.009
Cr	1457	0.07	0.400	0.009	0.008	1243	.304	.000	1582	0.80	0.100	0.017	0.031
Mn	1889	0.24	0.400	0.018	0.020	1849	.403	.000	2062	0.36	0.400	0.046	0.040
Fe	2284	1.99	5.000	0.213	0.196	2278	.663	.000	2287	12.60	66.800	1.539	1.221
Ni	1633	0.05	0.400	0.005	0.005	1413	.464	.000	1654	0.06	0.100	0.005	0.005
Cu	1508	1.95	0.400	0.064	0.157	1265	.569	.000	1484	0.57	0.100	0.022	0.040
Zn	2229	3.08	0.400	0.130	0.228	2158	.636	.000	2201	6.91	0.100	0.116	0.272
Ga	505	0.01	0.400	0.002	0.001	224	.364	.000	775	0.02	0.300	0.002	0.001
As	1141	0.13	0.400	0.006	0.009	598	.509	.000	914	0.19	0.400	0.005	0.009
Se	1915	0.07	0.400	0.004	0.005	1004	.138	.000	1057	0.01	0.100	0.001	0.001
Br	2283	2.56	1.500	0.143	0.226	1972	.814	.000	1981	0.33	0.100	0.028	0.031
Rb	1014	0.01	0.400	0.002	0.002	867	.577	.000	1688	0.02	0.200	0.003	0.003
Sr	1237	0.08	0.400	0.003	0.004	1209	.245	.000	2173	0.13	0.400	0.010	0.009
Cd	1432	0.41	0.400	0.009	0.021	705	.505	.000	913	0.21	0.100	0.012	0.012
Sn	1702	0.31	0.400	0.014	0.025	668	.312	.000	789	0.10	0.100	0.007	0.007
Sb	1534	0.32	0.400	0.005	0.010	810	.133	.000	1065	0.13	0.100	0.006	0.006
Ba	1410	0.20	0.400	0.011	0.015	1260	.597	.000	2011	0.47	0.100	0.034	0.034
Hg	1188	0.05	0.400	0.003	0.005	731	.268	.000	1035	0.02	0.400	0.002	0.002
Pb	2284	6.93	22.700	0.586	0.698	2273	.756	.000	2282	2.77	1.800	0.176	0.176

* Units are $\mu g/m^3$ # Units are ng/m^3

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TABLE G.2 RELATIONSHIPS BETWEEN FINE AND COARSE FRACTIONS FOR MASS AND 23 ELEMENTS (STATION 105)

	Fine fraction					Fine-coarse correlation			Coarse fraction				
Elmt.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*	No. of Cases	Coeff.	Sig.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*
MS	2260	0.17	1.100	0.027	0.018	2184	.590	.000	2256	162.4	1.500	0.268	0.018
P	1672	0.49	0.100	0.048	0.055	1610	.471	.000	2253	1.66	0.200	0.131	0.169
S	2354	22.88	136.600	3.227	2.899	2306	.558	.000	2322	4.50	0.100	0.411	0.387
Cl	1791	6.20	0.400	0.210	0.299	1437	.192	.000	1760	9.51	0.600	0.446	0.718
Ti	1680	2.66	0.100	0.050	0.123	1644	.913	.000	2241	8.88	0.300	0.203	0.495
Va	1265	0.07	0.100	0.008	0.008	676	.367	.000	1088	0.17	0.100	0.009	0.010
Cr	1695	0.12	0.400	0.010	0.009	1385	.207	.000	1793	0.96	0.100	0.016	0.030
Mn	2166	0.98	0.400	0.028	0.047	2116	.604	.000	2300	1.80	0.400	0.031	0.048
Fe	2356	6.82	5.300	0.256	0.330	2343	.722	.000	2357	1.47	36.700	1.120	1.030
Ni	1873	0.11	0.400	0.006	0.007	1597	.428	.000	1879	0.14	0.100	0.005	0.008
Cu	1720	6.01	0.400	0.084	0.313	1403	.618	.000	1605	1.47	0.100	0.025	0.080
Zn	2307	10.67	0.400	0.154	0.460	2238	.675	.000	2276	1.93	0.600	0.142	0.607
Ga	435	0.01	0.400	0.002	0.002	160	.424	.000	717	0.01	0.100	0.001	0.001
As	1046	0.20	0.400	0.007	0.013	495	.687	.000	860	0.55	0.400	0.007	0.028
Se	1981	0.09	0.400	0.004	0.006	1045	.229	.000	1174	0.03	0.100	0.001	0.001
Br	2347	2.47	1.200	0.149	0.172	2071	.841	.000	2052	0.43	0.100	0.037	0.036
Rb	1052	0.01	0.400	0.003	0.003	824	.787	.000	1609	0.02	0.100	0.003	0.003
Sr	1119	0.06	0.400	0.003	0.004	1078	.430	.000	2236	0.23	0.100	0.008	0.014
Cd	1345	0.47	0.400	0.012	0.026	678	.556	.000	908	0.51	0.100	0.008	0.030
Sn	1586	2.29	0.400	0.018	0.072	640	.284	.000	810	0.09	0.100	0.003	0.006
Sb	1578	0.15	0.400	0.005	0.008	760	.740	.000	1022	0.16	0.100	0.003	0.007
Ba	1405	0.28	0.400	0.014	0.025	1263	.582	.000	2070	0.54	0.100	0.030	0.043
Hg	1079	0.07	0.400	0.003	0.005	619	.389	.000	973	0.04	0.400	0.002	0.002
Pb	2356	12.85	48.000	0.657	0.670	2343	.690	.000	2357	2.88	4.200	0.196	0.218

* Units are $\mu g/m^3$ # Units are ng/m^3

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TABLE G.3 RELATIONSHIPS BETWEEN FINE AND COARSE FRACTIONS FOR MASS AND 23 ELEMENTS (STATION 106)

	Fine fraction					Fine-coarse correlation			Coarse fraction				
Elmt.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*	No. of Cases	Coeff.	Sig.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*
MS	828	0.11	1.000	0.025	0.015	776	.552	.000	791	0.08	1.900	0.012	0.001
P	628	0.60	0.400	0.068	0.103	623	.446	.000	843	1.63	2.000	0.141	0.001
S	844	21.64	308.800	3.467	2.852	842	.685	.000	846	3.09	7.200	0.308	0.001
Cl	711	0.59	0.800	0.097	0.089	705	.180	.000	827	4.64	1.200	0.389	0.001
Ti	767	1.94	0.300	0.106	0.200	766	.930	.000	847	8.96	0.700	0.856	0.002
Va	604	0.06	0.100	0.007	0.007	397	.341	.000	494	0.07	0.100	0.008	0.001
Cr	765	0.08	0.200	0.010	0.011	718	.587	.000	770	0.15	0.100	0.013	0.001
Mn	830	2.92	0.400	0.061	0.230	827	.558	.000	844	0.53	0.600	0.034	0.001
Fe	844	3.61	8.500	0.280	0.337	844	.502	.000	848	7.39	48.600	0.765	0.001
Ni	808	0.08	0.200	0.006	0.007	773	.690	.000	806	0.03	0.100	0.005	0.001
Cu	760	2.98	0.200	0.042	0.154	683	.880	.000	716	0.53	0.100	0.031	0.002
Zn	844	2.92	0.200	0.112	0.188	842	.590	.000	846	4.74	1.000	0.187	0.003
Ga	189	0.02	0.200	0.003	0.003	101	.350	.000	303	0.01	0.100	0.001	0.001
As	375	0.10	0.200	0.005	0.008	139	.810	.000	238	0.10	0.200	0.007	0.003
Se	767	0.03	0.200	0.004	0.004	525	.463	.000	540	0.01	0.100	0.001	0.001
Br	844	1.90	23.200	0.187	0.184	843	.840	.000	847	0.22	0.200	0.032	0.001
Rb	534	0.02	0.200	0.002	0.004	498	.714	.000	770	0.01	0.100	0.003	0.001
Sr	561	0.04	0.200	0.004	0.007	560	.493	.000	845	0.06	0.200	0.005	0.001
Cd	687	0.11	0.200	0.006	0.010	356	.648	.000	409	0.12	0.100	0.008	0.002
Sn	649	0.35	0.200	0.012	0.025	229	.540	.000	260	0.02	0.100	0.003	0.002
Sb	658	0.14	0.200	0.005	0.010	277	.169	.002	315	0.09	0.100	0.006	0.002
Ba	614	1.01	0.200	0.032	0.085	602	.763	.000	826	0.91	0.400	0.086	0.002
Hg	464	0.08	0.200	0.004	0.008	370	.553	.000	485	0.02	0.200	0.002	0.001
Pb	844	4.97	108.300	0.757	0.549	843	.761	.000	847	1.05	17.100	0.137	0.001

* Units are $\mu g/m^3$ # Units are ng/m^3

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TABLE G.4 RELATIONSHIPS BETWEEN FINE AND COARSE FRACTIONS FOR MASS AND 23 ELEMENTS (STATION 108)

	Fine fraction					Fine-coarse correlation			Coarse fraction				
Elmt.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*	No. of Cases	Coeff.	Sig.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*
MS	882	0.13	1.700	0.026	0.015	848	.482	.000	895	0.09	0.900	0.025	0.015
P	593	1.04	0.400	0.072	0.139	584	.656	.000	918	1.92	0.500	0.147	0.210
S	930	24.44	21.400	3.444	2.802	913	.434	.000	918	2.63	1.700	0.411	0.330
Cl	796	4.62	0.200	0.165	0.235	714	.467	.000	816	4.91	0.600	0.336	0.393
Ti	839	0.36	0.100	0.023	0.032	829	.826	.000	920	2.15	0.800	0.113	0.144
Va	741	0.10	0.100	0.008	0.008	591	.472	.000	698	0.12	0.100	0.009	0.011
Cr	821	0.05	0.200	0.007	0.006	741	.623	.000	821	0.20	0.100	0.018	0.026
Mn	906	0.17	0.200	0.023	0.025	896	.562	.000	924	0.91	0.200	0.052	0.058
Fe	930	2.62	6.500	0.265	0.303	924	.624	.000	928	8.92	41.100	1.442	1.441
Ni	837	0.82	0.200	0.005	0.006	770	.588	.000	833	0.06	0.100	0.005	0.006
Cu	770	0.45	0.200	0.032	0.053	657	.581	.000	700	0.25	0.100	0.013	0.021
Zn	924	3.67	0.600	0.142	0.227	894	.757	.000	902	3.11	0.300	0.085	0.171
Ga	177	0.02	0.200	0.002	0.003	116	.447	.000	422	0.02	0.200	0.001	0.001
As	547	0.12	0.200	0.005	0.008	314	.701	.000	454	0.18	0.200	0.005	0.015
Se	876	0.63	0.200	0.003	0.004	570	.415	.000	583	0.01	0.100	0.001	0.001
Br	928	1.31	5.400	0.142	0.181	864	.805	.000	869	0.22	0.300	0.029	0.030
Rb	580	0.01	0.200	0.002	0.002	517	.213	.000	795	0.01	0.100	0.002	0.001
Sr	547	0.01	0.200	0.001	0.001	538	.512	.000	906	0.07	0.200	0.007	0.006
Cd	648	0.15	0.200	0.006	0.011	314	.636	.000	365	0.04	0.100	0.003	0.004
Sn	767	0.69	0.200	0.013	0.030	432	.876	.000	465	0.34	0.100	0.005	0.019
Sb	688	0.11	0.200	0.004	0.008	394	.643	.000	455	0.06	0.100	0.003	0.005
Ba	577	0.11	0.200	0.007	0.011	535	.603	.000	851	0.21	0.100	0.019	0.022
Hg	524	0.02	0.200	0.002	0.002	381	.301	.000	524	0.02	0.200	0.002	0.002
Pb	930	12.50	1.300	0.618	0.708	922	.820	.000	926	9.88	0.500	0.168	0.386

* Units are $\mu g/m^3$ # Units are ng/m^3

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TABLE G.5 RELATIONSHIPS BETWEEN FINE AND COARSE FRACTIONS FOR MASS AND 23 ELEMENTS (STATION 112)

	Fine fraction					Fine-coarse correlation			Coarse fraction				
Elmt.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*	No. of Cases	Coeff.	Sig.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*
MS	1241	0.10	1.400	0.025	0.016	1116	.479	.000	1127	0.34	1.000	0.029	0.026
P	697	0.49	0.200	0.053	0.072	679	.604	.000	1205	0.82	0.600	0.118	0.114
S	1242	20.33	155.500	3.382	2.894	1169	.560	.000	1181	3.19	2.600	0.406	0.361
Cl	845	2.40	0.200	0.124	0.164	758	.192	.000	1056	15.62	0.700	0.539	1.105
Ti	879	1.11	0.100	0.052	0.099	866	.868	.000	1151	4.97	0.500	0.218	0.359
Va	724	0.06	0.100	0.007	0.006	532	.350	.000	726	0.05	0.100	0.008	0.007
Cr	806	0.08	0.200	0.007	0.007	729	.526	.000	930	0.12	0.100	0.011	0.012
Mn	1058	0.66	0.200	0.024	0.044	1026	.572	.000	1144	0.39	0.200	0.032	0.033
Fe	1239	1.90	3.700	0.167	0.162	1231	.417	.000	1246	15.27	24.700	1.080	1.164
Ni	945	0.05	0.200	0.004	0.005	828	.511	.000	952	0.05	0.100	0.004	0.004
Cu	989	1.71	0.200	0.026	0.090	791	.696	.000	855	0.33	0.100	0.010	0.015
Zn	1171	2.63	0.600	0.079	0.138	1105	.572	.000	1138	2.00	0.100	0.048	0.104
Ga	161	0.01	0.200	0.002	0.002	65	.384	.001	358	0.01	0.200	0.001	0.001
As	453	0.06	0.200	0.005	0.007	172	.559	.000	362	0.03	0.200	0.003	0.005
Se	986	0.03	0.200	0.003	0.003	595	.356	.000	651	0.01	0.100	0.001	0.001
Br	1236	1.83	2.500	0.209	0.218	1146	.824	.000	1161	0.73	0.300	0.051	0.049
Rb	497	0.01	0.200	0.002	0.002	446	.574	.000	962	0.04	0.100	0.003	0.003
Sr	647	0.38	0.200	0.003	0.016	629	.265	.000	1130	0.14	0.100	0.007	0.008
Cd	711	0.07	0.200	0.005	0.008	309	.546	.000	395	0.04	0.100	0.002	0.004
Sn	726	0.39	0.200	0.010	0.024	239	.389	.000	319	0.10	0.100	0.002	0.006
Sb	809	2.99	0.200	0.008	0.105	350	.699	.000	453	0.11	0.100	0.003	0.008
Ba	800	0.67	0.200	0.015	0.039	738	.661	.000	1118	0.52	0.100	0.028	0.038
Hg	637	0.09	0.200	0.004	0.009	450	.737	.000	646	0.02	0.200	0.002	0.003
Pb	1239	6.51	59.400	0.809	0.713	1230	.772	.000	1245	3.81	6.600	0.220	0.221

* Units are $\mu g/m^3$ # Units are ng/m^3

TABLE G.6 RELATIONSHIPS BETWEEN FINE AND COARSE FRACTIONS FOR MASS AND 23 ELEMENTS (STATION 115)

	Fine fraction					Fine-coarse correlation			Coarse fraction				
Elmt.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*	No. of Cases	Coeff.	Sig.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*
MS	1021	0.09	2.100	0.022	0.012	877	.494	.000	888	0.08	1.000	0.020	0.012
P	609	0.37	0.100	0.062	0.078	593	.585	.000	1037	0.68	0.500	0.092	0.089
S	1096	22.90	208.700	3.174	2.562	1014	.612	.000	1020	2.72	1.400	0.281	0.238
Cl	720	1.55	0.400	0.069	0.089	610	.183	.000	833	6.16	0.100	0.212	0.353
Ti	787	0.39	0.100	0.016	0.026	756	.805	.000	940	2.71	0.400	0.087	0.132
Va	652	0.05	0.100	0.005	0.005	437	.225	.000	549	0.04	0.100	0.005	0.005
Cr	743	0.03	0.200	0.005	0.004	599	.284	.000	712	0.04	0.100	0.006	0.005
Mn	945	0.16	0.200	0.009	0.011	873	.343	.000	933	0.29	0.200	0.022	0.021
Fe	1094	0.93	2.400	0.112	0.087	1085	.525	.000	1093	4.81	5.900	0.645	0.482
Ni	851	0.03	0.200	0.004	0.004	701	.467	.000	756	0.02	0.100	0.003	0.002
Cu	810	0.55	0.200	0.032	0.059	606	.705	.000	672	0.23	0.100	0.012	0.019
Zn	1075	1.66	0.200	0.109	0.178	994	.573	.000	1006	0.50	0.100	0.046	0.062
Ga	181	0.01	0.200	0.001	0.001	96	.582	.000	344	0.004	0.100	0.0007	0.0006
As	606	0.03	0.200	0.003	0.004	268	.402	.000	390	0.01	0.200	0.002	0.002
Se	1004	0.34	0.200	0.004	0.013	426	.817	.000	431	0.01	0.100	0.001	0.001
Br	1095	0.85	0.800	0.064	0.064	973	.694	.000	979	0.31	0.100	0.017	0.019
Rb	458	0.004	0.200	0.0007	0.0005	362	.039	.230	764	0.01	0.200	0.001	0.001
Sr	466	0.01	0.200	0.001	0.001	439	.369	.000	944	0.03	0.200	0.004	0.004
Cd	655	0.24	0.200	0.006	0.014	281	.571	.000	358	0.03	0.100	0.002	0.003
Sn	853	0.38	0.200	0.013	0.027	366	.468	.000	426	0.02	0.100	0.002	0.002
Sb	707	0.06	0.200	0.002	0.004	329	.124	.012	417	0.01	0.100	0.001	0.001
Ba	611	0.10	0.200	0.006	0.008	525	.481	.000	929	0.12	0.100	0.013	0.013
Hg	512	0.01	0.200	0.002	0.002	283	.466	.000	386	0.004	0.200	0.001	0.001
Pb	1095	4.89	20.600	0.364	0.332	1078	.707	.000	1084	0.95	0.700	0.976	0.079

* Units are $\mu g/m^3$ # Units are ng/m^3

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TABLE G.7 RELATIONSHIPS BETWEEN FINE AND COARSE FRACTIONS FOR MASS AND 23 ELEMENTS (STATION 118)

	Fine fraction					Fine-coarse correlation			Coarse fraction				
Elmt.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*	No. of Cases	Coeff.	Sig.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*
MS	884	0.08	1.900	0.019	0.012	861	.418	.000	900	0.10	0.600	0.018	0.012
P	510	0.76	0.100	0.056	0.122	495	.781	.000	898	1.63	0.300	0.077	0.122
S	919	22.89	259.600	2.760	2.445	901	.649	.000	908	1.58	0.800	0.247	0.213
Cl	537	0.34	0.200	0.067	0.061	467	.106	.011	719	3.67	0.600	0.222	0.332
Ti	666	0.58	0.100	0.039	0.074	651	.806	.000	832	3.23	0.200	0.150	0.270
Va	446	0.03	0.100	0.004	0.004	256	.378	.000	372	0.03	0.100	0.004	0.005
Cr	565	0.02	0.200	0.004	0.003	474	.366	.000	593	0.04	0.200	0.005	0.004
Mn	769	0.10	0.200	0.008	0.011	744	.443	.000	825	0.16	0.200	0.015	0.013
Fe	916	0.99	2.000	0.117	0.104	906	.489	.000	915	3.52	1.000	0.593	0.442
Ni	649	0.03	0.200	0.002	0.003	542	.538	.000	635	0.03	0.100	0.002	0.003
Cu	624	0.61	0.200	0.015	0.046	428	.728	.000	509	0.12	0.100	0.006	0.011
Zn	888	1.59	0.400	0.058	0.108	831	.750	.000	844	0.74	0.200	0.029	0.059
Ga	148	0.01	0.200	0.001	0.001	79	.716	.000	330	0.003	0.100	0.0006	0.0005
As	484	0.02	0.200	0.003	0.003	196	.323	.000	325	0.02	0.200	0.001	0.001
Se	829	0.04	0.200	0.003	0.004	408	.301	.000	417	0.003	0.100	0.0005	0.0005
Br	907	0.32	1.200	0.043	0.036	712	.828	.000	719	0.08	0.100	0.012	0.010
Rb	454	0.003	0.200	0.0006	0.0005	385	.208	.000	727	0.01	0.100	0.001	0.001
Sr	512	0.06	0.200	0.001	0.003	498	.177	.000	881	0.04	0.200	0.004	0.004
Cd	557	0.12	0.200	0.007	0.012	281	.613	.000	345	0.03	0.100	0.002	0.003
Sn	519	0.18	0.200	0.006	0.013	138	.678	.000	187	0.02	0.100	0.001	0.002
Sb	537	0.15	0.200	0.002	0.008	208	.115	.050	302	0.01	0.100	0.001	0.001
Ba	608	0.39	0.200	0.014	0.038	565	.814	.000	834	0.38	0.200	0.021	0.035
Hg	390	0.01	0.200	0.001	0.001	250	.343	.000	358	0.01	0.200	0.001	0.001
Pb	918	2.29	11.900	0.286	0.259	901	.700	.000	909	1.86	2.100	0.084	0.125

* Units are $\mu g/m^3$ # Units are ng/m^3

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TABLE G.8 RELATIONSHIPS BETWEEN FINE AND COARSE FRACTIONS FOR MASS AND 23 ELEMENTS (STATION 120)

		Fine fraction				Fine-coarse correlation				Coarse fraction			
Elmt.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*	No. of Cases	Coeff.	Sig.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*
MS	1023	0.09	1.100	0.022	0.013	983	.560	.000	1032	0.05	0.900	0.017	0.009
P	560	0.23	0.200	0.017	0.023	544	.277	.000	1037	0.41	0.400	0.058	0.050
S	1058	23.21	171.600	2.741	2.406	1028	.732	.000	1044	1.89	2.100	0.201	0.182
Cl	721	0.68	0.200	0.075	0.072	596	.150	.000	789	10.69	0.100	0.287	0.736
Ti	734	0.37	0.200	0.024	0.039	716	.873	.000	939	1.48	0.200	0.086	0.139
Va	528	0.04	0.100	0.007	0.007	326	.588	.000	452	0.04	0.100	0.008	0.009
Cr	672	0.04	0.200	0.006	0.005	564	.559	.000	687	0.05	0.100	0.007	0.007
Mn	869	0.15	0.200	0.011	0.015	828	.683	.000	900	0.11	0.200	0.014	0.012
Fe	1051	0.87	2.100	0.114	0.099	1036	.532	.000	1059	2.17	22.000	0.521	0.358
Ni	778	0.05	0.200	0.004	0.005	616	.618	.000	681	0.02	0.100	0.002	0.002
Cu	696	0.22	0.200	0.011	0.018	452	.560	.000	503	0.04	0.100	0.004	0.005
Zn	1009	0.72	0.400	0.051	0.069	944	.708	.000	970	0.54	0.100	0.022	0.032
Ga	131	0.01	0.200	0.002	0.002	39	.147	.186	181	0.002	0.200	0.0007	0.0004
As	409	0.03	0.200	0.003	0.003	116	.612	.000	248	0.02	0.200	0.001	0.002
Se	788	0.02	0.200	0.003	0.002	329	.431	.000	361	0.003	0.100	0.0006	0.0004
Br	1056	1.58	17.100	0.167	0.170	1015	.787	.000	1032	0.27	0.100	0.037	0.032
Rb	264	0.004	0.200	0.0007	0.0006	211	.187	.003	618	0.01	0.200	0.001	0.001
Sr	347	0.01	0.200	0.001	0.001	330	.229	.000	862	0.04	0.200	0.003	0.003
Cd	654	0.05	0.200	0.003	0.005	279	.718	.000	335	0.02	0.100	0.001	0.001
Sn	619	0.07	0.200	0.005	0.007	174	.524	.000	246	0.03	0.100	0.001	0.002
Sb	687	0.03	0.200	0.002	0.003	277	.276	.000	384	0.01	0.100	0.001	0.001
Ba	699	0.10	0.200	0.007	0.010	633	.487	.000	942	0.13	0.100	0.014	0.014
Hg	373	0.97	0.200	0.003	0.006	201	.819	.000	328	0.02	0.200	0.001	0.002
Pb	1056	3.99	70.000	0.604	0.466	1041	.871	.000	1059	0.96	1.600	0.140	0.105

* Units are $\mu g/m^3$ # Units are ng/m^3

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TABLE G.9 RELATIONSHIPS BETWEEN FINE AND COARSE FRACTIONS FOR MASS AND 23 ELEMENTS (STATION 122)

	Fine fraction					Fine-coarse correlation			Coarse fraction				
Elmt.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*	No. of Cases	Coeff.	Sig.	No. of Cases	Max.*	Min.#	Mean*	Std. dev.*
MS	916	0.08	0.900	0.020	0.013	891	.455	.000	903	0.09	0.700	0.018	0.013
P	434	0.76	0.100	0.094	0.150	428	.592	.000	918	1.08	0.100	0.107	0.140
S	925	15.53	141.500	2.846	2.500	894	.515	.000	898	1.31	1.300	0.218	0.194
Cl	470	0.34	0.200	0.059	0.057	442	.111	.010	725	2.06	0.300	0.157	0.177
Ti	477	0.09	0.100	0.013	0.015	472	.678	.000	790	0.35	0.500	0.059	0.054
Va	357	0.03	0.100	0.004	0.004	228	.380	.000	358	0.03	0.100	0.005	0.005
Cr	461	0.02	0.100	0.004	0.003	368	.456	.000	514	0.03	0.100	0.005	0.005
Mn	671	0.15	0.200	0.008	0.011	653	.455	.000	768	0.09	0.200	0.015	0.012
Fe	901	0.73	0.800	0.099	0.085	900	.557	.000	927	2.04	4.600	0.517	0.353
Ni	520	0.02	0.100	0.003	0.003	408	.457	.000	525	0.03	0.100	0.002	0.002
Cu	561	0.17	0.200	0.015	0.022	363	.443	.000	412	0.07	0.100	0.005	0.007
Zn	854	0.79	0.200	0.067	0.095	802	.806	.000	806	0.56	0.100	0.028	0.043
Ga	172	0.01	0.100	0.001	0.001	89	.677	.000	296	0.01	0.100	0.001	0.001
As	496	0.02	0.100	0.002	0.002	229	.369	.000	330	0.01	0.100	0.001	0.001
Se	784	0.02	0.200	0.003	0.003	340	.331	.000	353	0.003	0.100	0.0006	0.0005
Br	878	0.19	0.400	0.026	0.026	657	.748	.000	658	0.05	0.100	0.007	0.006
Rb	414	0.004	0.100	0.0007	0.0006	336	.157	.002	642	0.01	0.100	0.001	0.001
Sr	332	0.004	0.100	0.0007	0.0007	327	.461	.000	830	0.03	0.200	0.003	0.003
Cd	457	0.07	0.100	0.003	0.005	162	.415	.000	220	0.01	0.100	0.001	0.001
Sn	594	0.11	0.100	0.012	0.018	201	.246	.000	252	0.01	0.100	0.001	0.001
Sb	573	0.02	0.100	0.002	0.002	244	.075	.122	330	0.003	0.100	0.0009	0.0007
Ba	558	0.06	0.100	0.005	0.006	504	.514	.000	811	0.08	0.100	0.010	0.009
Hg	323	0.01	0.100	0.001	0.001	170	.065	.201	285	0.01	0.100	0.001	0.001
Pb	925	1.64	9.500	0.188	0.182	900	.840	.000	902	0.30	0.100	0.032	0.037

* Units are $\mu g/m^3$ # Units are ng/m^3

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TABLE G.10 RELATIONSHIPS BETWEEN FINE AND COARSE FRACTIONS FOR MASS AND 23 ELEMENTS (STATION 124)

Elmt.	Fine fraction No. of Cases	Fine fraction Max.*	Fine fraction Min.#	Fine fraction Mean*	Fine fraction Std. dev.*	Fine-coarse correlation No. of Cases	Fine-coarse correlation Coeff.	Fine-coarse correlation Sig.	Coarse fraction No. of Cases	Coarse fraction Max.*	Coarse fraction Min.#	Coarse fraction Mean*	Coarse fraction Std. dev.*
MS	720	0.07	1.600	0.017	0.010	706	.332	.000	720	0.05	0.500	0.014	0.009
P	400	0.62	0.100	0.077	0.125	376	.715	.000	650	0.82	0.200	0.077	0.100
S	731	18.05	250.100	2.743	2.437	682	.726	.000	685	1.79	0.900	0.238	0.226
Cl	342	0.54	0.200	0.050	0.059	285	-.001	.491	514	1.67	0.300	0.132	0.145
Ti	459	0.16	0.100	0.011	0.013	419	.508	.000	534	0.67	0.100	0.057	0.066
Va	355	0.05	0.100	0.007	0.007	233	.760	.000	304	0.03	0.100	0.008	0.008
Cr	421	0.04	0.200	0.005	0.004	356	.439	.000	440	0.05	0.100	0.007	0.006
Mn	539	0.10	0.200	0.007	0.012	465	.344	.000	533	0.06	0.200	0.012	0.010
Fe	725	0.59	1.300	0.088	0.070	689	.302	.000	697	1.86	0.300	0.389	0.294
Ni	440	0.04	0.100	0.002	0.002	330	.357	.000	429	0.02	0.100	0.002	0.002
Cu	338	0.07	0.200	0.006	0.011	158	.470	.000	235	0.04	0.100	0.004	0.005
Zn	680	1.29	0.400	0.032	0.070	570	.532	.000	582	0.21	0.100	0.015	0.023
Ga	135	0.004	0.100	0.0005	0.0005	55	.395	.001	226	0.004	0.100	0.0006	0.0005
As	387	0.01	0.100	0.002	0.002	161	.232	.002	232	0.01	0.100	0.001	0.001
Se	617	0.17	0.200	0.003	0.010	185	.466	.000	207	0.004	0.100	0.0006	0.0006
Br	711	0.18	0.600	0.024	0.020	362	.788	.000	367	0.05	0.100	0.008	0.008
Rb	324	0.01	0.100	0.001	0.001	218	.263	.000	374	0.01	0.100	0.002	0.002
Sr	287	0.02	0.100	0.001	0.002	228	.099	.068	511	0.02	0.100	0.003	0.003
Cd	388	0.11	0.100	0.005	0.011	189	.669	.000	278	0.04	0.100	0.003	0.006
Sn	350	0.03	0.100	0.002	0.004	85	-.069	.265	132	0.01	0.100	0.001	0.001
Sb	387	0.06	0.100	01001	0.003	136	-.009	.460	219	0.01	0.100	0.001	0.001
Ba	436	0.08	0.100	0.004	0.005	353	.394	.000	583	0.11	0.100	0.011	0.011
Hg	172	0.003	0.100	0.0006	0.0005	60	.222	.044	131	0.003	0.100	0.0008	0.0007
Pb	739	4.31	9.600	0.170	0.249	651	.696	.000	655	1.13	0.100	0.047	0.088

* Units are $\mu g/m^3$ # Units are ng/m^3

APPENDIX H

CORRELATION COEFFICIENTS AMONG SELECTED ELEMENTS BY STATION BY FRACTION

103

TABLE H.1 CORRELATION COEFFICIENTS AMONG SELECTED ELEMENTS AT STATION 103

(Coarse fraction above the diagonal; fine fraction below the diagonal)

	MS	S	TI	FE	ZN	BR	PB
MS	1.000 0 *****	.5222 2319 .000	.3383 2100 .000	.7767 2388 .000	.2700 2295 .000	.4521 2073 .000	.4029 2383 .000
S	.7381 2396 .000	1.000 0 *****	.1589 2154 .000	.3726 2451 .000	.1917 2360 .000	.2674 2138 .000	.2543 2446 .000
TI	.2020 1502 .000	.1249 1547 .000	1.000 0 *****	.4489 2206 .000	.2038 2156 .000	.2342 2005 .000	.4296 2205 .000
FE	.3320 2426 .000	.1817 2502 .000	.3339 1575 .000	1.000 0 *****	.3105 2419 .000	.5491 2199 .000	.5274 2522 .000
ZN	.2194 2357 .000	.1462 2421 .000	.2711 1555 .000	.3927 2455 .000	1.000 0 *****	.2666 2139 .000	.4209 2417 .000
BR	.3719 2425 .000	.0988 2501 .000	.1031 1575 .000	.3320 2535 .000	.1297 2454 .000	1.000 0 *****	.7166 2199 .000
PB	.4633 2426 .000	.1954 2502 .000	.3372 1575 .000	.4381 2536 .000	.3883 2455 .000	.8478 2535 .000	1.000 0 *****

Each Cell Contains: Correlation Coefficient
Number of Cases
Significance

TABLE H.2 CORRELATION COEFFICIENTS AMONG SELECTED ELEMENTS AT STATION 105

(Coarse fraction above the diagonal; fine fraction below the diagonal)

	MS	S	TI	FE	ZN	BR	PB
MS	1.000 0 *****	.8007 2444 .000	.1635 1731 .000	.2858 2446 .000	.2992 2389 .000	.1274 2432 .000	.3507 2446 .000
S	.6499 2370 .000	1.000 0 *****	.0697 1823 .001	.0918 2607 .000	.2005 2541 .000	-.1024 2590 .000	.0867 2608 .000
TI	.3080 2293 .000	.2275 2411 .000	1.000 0 *****	.3773 1825 .000	.0690 1796 .002	.1066 1817 .000	.2410 1825 .000
FE	.7475 2414 .000	.6243 2548 .000	.5172 2458 .000	1.000 0 *****	.0904 2543 .000	.2041 2592 .000	.2897 2609 .000
ZN	.2364 2315 .000	.4746 2465 .000	.0060 2351 .385	.2537 2483 .000	1.000 0 *****	.0052 2539 .396	.3505 2543 .000
BR	.3637 2126 .000	.3243 2255 .000	.1679 2141 .000	.3031 2271 .000	.0325 2246 .062	1.000 0 *****	.7005 2592 .000
PB	.4033 2411 .000	.4725 2547 .000	.2848 2456 .000	.4805 2601 .000	.3663 2483 .000	.5552 2271 .000	1.000 0 *****

Each Cell Contains: Correlation Coefficient
Number of Cases
Significance

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TABLE H.3 CORRELATION COEFFICIENTS AMONG SELECTED ELEMENTS AT STATION 106

(Coarse fraction above the diagonal; fine fraction below the diagonal)

	MS	S	TI	FE	ZN	BR	PB
MS	1.000 0 *****	.8454 920 .000	.2072 830 .000	.2389 919 .000	.3090 919 .000	.0788 919 .008	.3143 919 .000
S	.4932 877 .000	1.000 0 *****	.1555 846 .000	.0439 941 .089	.2046 941 .000	-.1223 941 .000	.1061 941 .001
TI	.3833 875 .000	.2745 940 .000	1.000 0 *****	.4213 847 .000	-.0510 847 .069	-.0816 847 .009	.0107 847 .378
FE	.7163 878 .000	.4363 943 .000	.7686 942 .000	1.000 0 *****	.1339 942 .000	.1603 942 .000	.2602 942 .000
ZN	.2340 877 .000	.1842 942 .000	-.0229 940 .242	.1433 943 .000	1.000 0 *****	.1102 942 .000	.3395 942 .000
BR	.1660 878 .000	.2518 943 .000	-.0739 941 .012	.1512 944 .000	.0964 943 .002	1.000 0 *****	.8969 942 .000
PB	.2758 878 .000	.2564 943 .000	.1038 941 .001	.3394 944 .000	.1811 943 .000	.7622 944 .000	1.000 0 *****

Each Cell Contains: Correlation Coefficient
Number of Cases
Significance

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TABLE H.4 CORRELATION COEFFICIENTS AMONG SELECTED ELEMENTS AT STATION 108

(Coarse fraction above the diagonal; fine fraction below the diagonal)

	MS	S	TI	FE	ZN	BR	PB
MS	1.000 0 *****	.8454 920 .000	.2072 830 .000	.2389 919 .000	.3090 919 .000	.0788 919 .008	.3143 919 .000
S	.4932 877 .000	1.000 0 *****	.1555 846 .000	.0439 941 .089	.2046 941 .000	-.1223 941 .000	.1061 941 .001
TI	.3833 875 .000	.2745 940 .000	1.000 0 *****	.4213 847 .000	-.0510 847 .069	-.0816 847 .009	.0107 847 .378
FE	.7163 878 .000	.4363 943 .000	.7686 942 .000	1.000 0 *****	.1339 942 .000	.1603 942 .000	.2602 942 .000
ZN	.2340 877 .000	.1842 942 .000	-.0229 940 .242	.1433 943 .000	1.000 0 *****	.1102 942 .000	.3395 942 .000
BR	.1660 878 .000	.2518 943 .000	-.0739 941 .012	.1512 944 .000	.0964 943 .002	1.000 0 *****	.8969 942 .000
PB	.2758 878 .000	.2564 943 .000	.1038 941 .001	.3394 944 .000	.1811 943 .000	.7622 944 .000	1.000 0 *****

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Number of Cases
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TABLE H.5 CORRELATION COEFFICIENTS AMONG SELECTED ELEMENTS AT STATION 112

(Coarse fraction above the diagonal; fine fraction below the diagonal)

	MS	S	TI	FE	ZN	BR	PB
MS	1.000 0 *****	.7685 1359 .000	.2608 957 .000	.3533 1356 .000	.2801 1276 .000	.2197 1353 .000	.3812 1357 .000
S	.6254 1188 .000	1.000 0 *****	.2164 978 .000	.2640 1411 .000	.2294 1317 .000	-.0363 1406 .087	.1437 1412 .000
TI	.3663 1144 .000	.3489 1234 .000	1.000 0 *****	.6369 978 .000	.1467 951 .000	.1797 976 .000	.2268 978 .000
FE	.8502 1256 .000	.6520 1319 .000	.5276 1290 .000	1.000 0 *****	.2909 1317 .000	.2518 1405 .000	.3269 1411 .000
ZN	.2020 1138 .000	.2923 1242 .000	.0742 1211 .005	.1903 1259 .000	1.000 0 *****	.1508 1316 .000	.3044 1317 .000
BR	.2324 1166 .000	.3685 1252 .000	.2160 1219 .000	.2321 1300 .000	.1403 1225 .000	1.000 0 *****	.8856 1406 .000
PB	.2390 1256 .000	.3132 1319 .000	.2271 1289 .000	.2476 1417 .000	.1823 1258 .000	.7219 1300 .000	1.000 0 *****

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Number of Cases
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TABLE H.6 CORRELATION COEFFICIENTS AMONG SELECTED ELEMENTS AT STATION 115

(Coarse fraction above the diagonal; fine fraction below the diagonal)

	MS	S	TI	FE	ZN	BR	PB
MS	1.000 0 *****	.8519 1085 .000	.2916 779 .000	.3465 1082 .000	.0503 1061 .051	.1379 1084 .000	.2694 1084 .000
S	.4420 932 .000	1.000 0 *****	.1352 836 .000	.2101 1162 .000	-.0754 1141 .005	-.0432 1166 .070	.0694 1166 .009
TI	.4390 866 .000	.3268 989 .000	1.000 0 *****	.6563 836 .000	.3743 836 .000	.2800 836 .000	.6012 836 .000
FE	.8051 944 .000	.4230 1093 .000	.6775 1007 .000	1.000 0 *****	.2070 1140 .000	.2531 1161 .000	.3997 1161 .000
ZN	.1460 899 .000	.1896 1032 .000	.3638 989 .000	.3496 1073 .000	1.000 0 *****	.2250 1140 .000	.6088 1140 .000
BR	.2797 838 .000	.3665 973 .000	.2418 924 .000	.3586 1045 .000	.2028 975 .000	1.000 0 *****	.7220 1165 .000
PB	.3435 941 .000	.3980 1090 .000	.5035 1003 .000	.5463 1161 .000	.4467 1072 .000	.8088 1038 .000	1.000 0 *****

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Number of Cases
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TABLE H.7 CORRELATION COEFFICIENTS AMONG SELECTED ELEMENTS AT STATION 118

(Coarse fraction above the diagonal; fine fraction below the diagonal)

	MS	S	TI	FE	ZN	BR	PB
MS	1.000 0 *****	.8955 1001 .000	.0488 754 .090	.4036 999 .000	.2221 973 .000	.1507 993 .000	.3158 1000 .000
S	.4111 1017 .000	1.000 0 *****	-.0051 770 .444	.2016 1048 .000	.0939 1013 .001	-.0318 1039 .153	.1288 1052 .000
TI	.2404 930 .000	.1603 962 .000	1.000 0 *****	.4430 771 .000	.0206 768 .285	.3363 771 .000	.1482 771 .000
FE	.7995 1025 .000	.3884 1055 .000	.5220 962 .000	1.000 0 *****	.4209 1014 .000	.3407 1038 .000	.3831 1049 .000
ZN	.3033 932 .000	.2708 958 .000	.1082 912 .001	.4977 963 .000	1.000 0 *****	.2969 1009 .000	.6129 1014 .000
BR	.3138 817 .000	.3966 843 .000	.4130 812 .000	.4345 847 .000	.3048 812 .000	1.000 0 *****	.5735 1040 .000
PB	.1721 1019 .000	.1321 1051 .000	.1075 961 .000	.2273 1058 .000	.3068 960 .000	.2557 845 .000	1.000 0 *****

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TABLE H.8 CORRELATION COEFFICIENTS AMONG SELECTED ELEMENTS AT STATION 120

(Coarse fraction above the diagonal; fine fraction below the diagonal)

	MS	S	TI	FE	ZN	BR	PB
MS	1.000 0 *****	.8196 1043 .000	.2667 708 .000	.3958 1035 .000	.3637 989 .000	.1954 1041 .000	.4321 1041 .000
S	.4084 1032 .000	1.000 0 *****	.1978 737 .000	.1840 1080 .000	.2180 1034 .000	-.1012 1086 .000	.1438 1086 .000
TI	.3131 921 .000	.3205 947 .000	1.000 0 *****	.4313 747 .000	.1614 745 .000	.0358 746 .165	.1380 747 .000
FE	.7994 1038 .000	.4578 1070 .000	.5089 960 .000	1.000 0 *****	.3958 1044 .000	.1423 1089 .000	.2580 1090 .000
ZN	.3823 953 .000	.3518 982 .000	.1990 938 .000	.5100 993 .000	1.000 0 *****	.1842 1043 .000	.3713 1044 .000
BR	.4679 1012 .000	.1893 1046 .000	.1886 947 .000	.4075 1064 .000	.2654 985 .000	1.000 0 *****	.9086 1095 .000
PB	.4925 1038 .000	.2422 1070 .000	.1926 960 .000	.4717 1093 .000	.3331 993 .000	.9308 1064 .000	1.000 0 *****

Each Cell Contains: Correlation Coefficient
Number of Cases
Significance

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TABLE H.9 CORRELATION COEFFICIENTS AMONG SELECTED ELEMENTS AT STATION 122
(Coarse fraction above the diagonal; fine fraction below the diagonal)

	MS	S	TI	FE	ZN	BR	PB
MS	1.000 0 *****	.8425 1022 .000	.3173 542 .000	.3992 997 .000	.3545 940 .000	.2483 969 .000	.4751 1022 .000
S	.5222 977 .000	1.000 0 *****	.1633 548 .000	.2921 1019 .000	.2336 956 .000	.0644 990 .021	.3067 1049 .000
TI	.5546 853 .000	.3199 866 .000	1.000 0 *****	.6731 549 .000	.4831 548 .000	.4579 548 .000	.5865 549 .000
FE	.7616 1007 .000	.4262 1014 .000	.7426 884 .000	1.000 0 *****	.5588 955 .000	.4306 981 .000	.5982 1020 .000
ZN	.1810 856 .000	.2485 869 .000	.3319 818 .000	.4193 884 .000	1.000 0 *****	.4471 942 .000	.7499 957 .000
BR	.2777 726 .000	.4077 741 .000	.4415 706 .000	.3913 755 .000	.3547 701 .000	1.000 0 *****	.7967 991 .000
PB	.1939 979 .000	.3204 989 .000	.5559 882 .000	.4746 1015 .000	.5054 883 .000	.7111 754 .000	1.000 0 *****

Each Cell Contains: Correlation Coefficient
Number of Cases
Significance

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TABLE H.10 CORRELATION COEFFICIENTS AMONG SELECTED ELEMENTS AT STATION 124
(Coarse fraction above the diagonal; fine fraction below the diagonal)

	MS	S	TI	FE	ZN	BR	PB
MS	1.000 0 *****	.7922 838 .000	.1185 530 .003	.2175 830 .000	.1261 776 .000	.1134 813 .001	.1566 837 .000
S	.4178 768 .000	1.000 0 *****	.0290 538 .251	.0980 848 .002	.0455 790 .101	.0330 832 .171	.0867 857 .006
TI	.4471 610 .000	.2401 619 .000	1.000 0 *****	.5135 538 .000	.2304 538 .000	.4671 538 .000	.2817 538 .000
FE	.7527 778 .000	.4435 809 .000	.6868 620 .000	1.000 0 *****	.2170 789 .000	.4464 824 .000	.2112 848 .000
ZN	.1283 653 .001	.1769 659 .000	.3171 593 .000	.3619 666 .000	1.000 0 *****	.2502 788 .000	.8902 790 .000
BR	.1150 441 .008	.3695 442 .000	.2550 382 .000	.3981 447 .000	.2826 414 .000	1.000 0 *****	.4326 832 .000
PB	.0527 739 .076	.0699 767 .026	.0681 613 .046	.1488 774 .000	.5053 653 .000	.4689 427 .000	1.000 0 *****

Each Cell Contains: Correlation Coefficient
Number of Cases
Significance

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